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Species composition and distribution of macrobenthos in the intertidal zone of Kunashir Island (South Kurile Islands), Russia

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Abstract Characteristics of vertical distribution, species composition and biogeographical structure of macrobenthos of the intertidal communities of Kunashir Island (South Kurile Islands) are described. In the rocky and bouldery intertidal zones, communities dominated by barnacle *Chthamalus dalli* and a gastropod species *Littorina sitkana* with the poor species composition of the macrobenthos are typical for the upper intertidal subzone. The middle intertidal subzone is occupied by fucoid assemblages. The dense beds of laminarian algae dominate in the lower intertidal subzone with the total macrobenthic biomass up to 100 kg wet wt m^{-2}. On wave-exposed sandy beaches formed by clean sand, populations of the macrobenthic organisms are very poor, and macrophytes and the other attached forms are absent. The communities dominated by eelgrass *Zostera japonica* and a gastropod species *Batillaria cumingii* are found only in the sandy intertidal zones of the southern coast of Kunashir Island, in Izmeny Bay. Reduction of species richness and increase of biomass of macrobenthos have been recorded from 1963 to 1991 in Izmeny Bay, and it is due to the fact that this area has been exposed to anthropogenic impact. At least, 563 species of macrobenthos are found in the intertidal zone of Kunashir Island. Pacific low-boreal and Pacific wide-boreal species are dominant. Warm-water species are more abundant in the intertidal zones of Izmeny Bay and on the Sea of Okhotsk coast as compared to those on the Pacific coast of Kunashir Island. It is probably associated with the flow patterns of the Soya Warm Current. Species composition and distribution of the intertidal macrobenthos of Kunashir Island are typical for the low-boreal intertidal zone with irregular diurnal and semi-diurnal tides. The intertidal zones of Kunashir Island and neighboring Shikotan Island have similar species composition and distribution patterns of the macrobenthic communities.

Keywords: South Kurile Islands, intertidal zone, macrobenthos, community, species composition, distribution, biogeographical composition, long-term changes.

Introduction

Kunashir Island is the southernmost island of the Greater Kurile Ridge. Its coastline is weakly indented, especially on the Sea of Okhotsk side, and the Pacific coast is exposed to wave action stronger than the western coast of Kunashir Island. Sandy beaches are dominant on the south and southeastern coasts, whereas the northern coast is rocky and occasionally has bouldery-pebbly shores.

The intertidal zone is the area between the high and low tide marks. The boundary position between the

two main habitats of life (air and water) is unique feature of the intertidal zone, also defined as the amphibiotic zone. Organisms that live in this zone experience daily and seasonal fluctuations of temperature and changes in salinity and moisture and they must be able to tolerate extreme environmental changes.

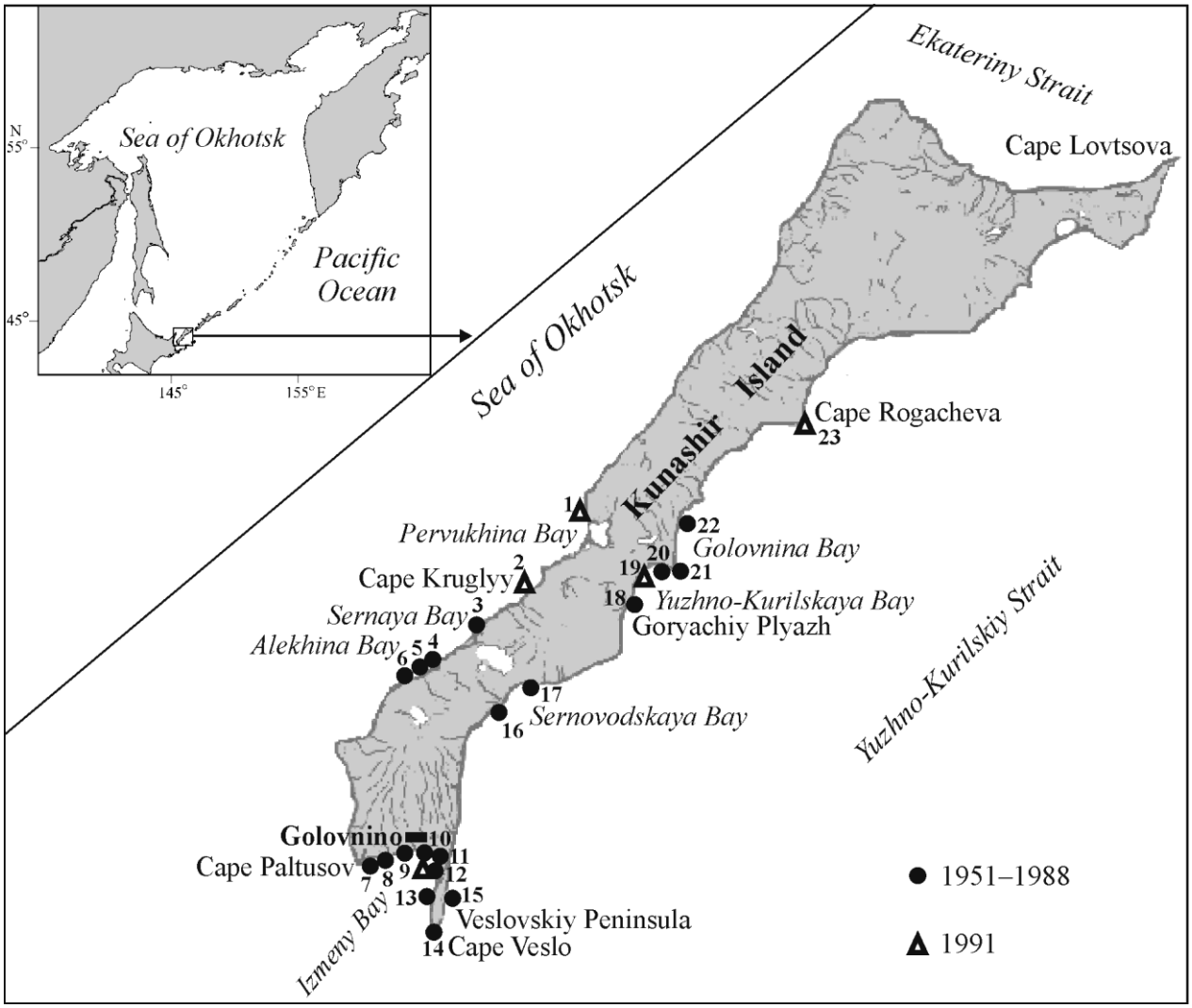

Figure 1. Schematic map of the sampling locations in the intertidal zones of Kunashir Island. 1 – Pervukhina Bay, 2 – Cape Kruglyy, 3 – Sernaya Bay; 4–6 – Alekhina Bay, 7 – Cape Paltusov, 8–13 – Izmeny Bay, 14 – Cape Veslo, 15 – Veslovskiy Peninsula, 16–17 – Sernovodskaya Bay, 18 – Goryachiy Plyazh (Hot Beach), 19–20 – Yuzhno-Kurilskaya Bay, 21–22 – Golovnina Bay, 23 – Cape Rogacheva. Detailed information about the sampling locations contains in Table 1.

The intertidal zones of Kunashir Island were intensively investigated under the leadership of Oleg G. Kussakin by the expeditions of Leningrad State University (at present, Saint Petersburg State University), Zoological Institute and Botanical Institute (at present, V.L. Komarov Botanical Institute) of the Russian Academy of Sciences. In summer of 1951, in summer and winter of 1954, and in winter of 1955, flora and fauna of the intertidal zones of Sernovodskaya, Alekhina, Yuzhno-Kurilskaya, Golovnina, and Izmeny bays were examined (Kussakin, 1956, 1957), but quantitative data were not obtained at that time. During summer months of 1963 and 1964, quantitative samplings were carried out in the same bays, as a rule, along the same transects of 1951, 1954, and 1955, and in addition to that, the intertidal investigations were conducted in

Sernaya Bay. On the basis of these results, quantitative data on distribution of the intertidal macrobenthos were obtained (Kussakin and Tarakanova, 1977). In autumn of 1987 and in spring of 1988, species composition and distribution patterns of macrobenthic communities were investigated in the intertidal zone of the Goryachiy Plyazh (Hot Beach) where shallow-water gasohydrothermal vents occur (Kostina, 1991) (Fig. 1; Table 1).

The latest coastal expedition on Kunashir Island was carried out in 1991 by personnel of the Laboratory of Chorology of the Institute of Marine Biology of the Far Eastern Branch of the Russian Academy of Sciences (at present, A.V. Zhirmunsky Institute of Marine Biology, National Scientific Center of Marine Biology, Far Eastern Branch, Russian Academy of Sciences). The intertidal zones of Pervukhina Bay, Cape Rogacheva and at Cape Kruglyy, not examined earlier, were investigated. In Yuzhno-Kurilskaya Bay, the sampling was carried out in a few kilometers south of the locations of previous studies. In Izmeny Bay, survey was conducted at one of the locations studied in 1963.

In the present paper, the species composition and distribution of macrobenthos in the intertidal zones of Kunashir Island is given on the results of the latest expedition in 1991. The distribution patterns of macrobenthos all over the intertidal zones of Kunashir Island are described by the summarized information of 1951–1988 and 1991. A biogeographical analysis of the intertidal biota has also been undertaken. A quantitative comparison of macrobenthos is carried out between the 1963 and 1991 in one and the same site of Izmeny Bay. Features of the intertidal biota of Kunashir Island are briefly compared to that of the neighboring Shikotan Island.

Materials and Methods

Field survey

Sampling was carried out at low tides in the intertidal zones of Kunashir Island, in July–August 1991. Samples had to be collected according to the methods used in chorological investigation in the intertidal zones (Kussakin and Kostina, 1996; Ivanova et al., 2001). Belt transects laid perpendicularly to the coastline between 0 m depth and level of the highest tide were used to estimate the distribution and species composition of macrobenthos in the intertidal communities (Handbook of Biodiversity Methods, 2005). Belt transects were performed on the western coast of Kunashir Island, on a reef in the northern part of Pervukhina Bay (location 1) and on a reef 1 km southward of Cape Kruglyy (location 2); on the southern coast, on a beach, in 1.5 km eastward of Golovnino Village in Izmeny Bay (location 10); on the eastern coast, on a small nameless cape in central part of Yuzhno-Kurilskaya Bay, 5 km southwesterly of Cape Zavodskoy (location 19) and in the tide pool on Cape Rogacheva (location 23) (Fig. 1; Table 1). The length of transect lines depended on the width and slope of the intertidal zones. The total length of transect was about 25 m on the sandy intertidal zone in Izmeny Bay, while on hard substrata, for instance, on reef in Pervukhina Bay, the transect line was not more 15 m lengths.

The shore along each transect was divided into three subzones, namely the upper, middle and lower subzones. Subdivision of the intertidal zones was conducted according to the principles of Vaillant (Vaillant, 1891). Because ice appears on the Kunashir Island coast in November, which can cause death of a portion of the intertidal biota, the estimations of sea levels and corresponding intertidal subzones were performed for tidal ranges from May to October. The boundaries of the upper, middle, and lower subzones are determined by the high water spring tides, high water neap tides, low water neap tides, and low water spring tides, respectively. Irregular diurnal and semi-diurnal tides are characteristic of Kunashir Island. The tides reach 1.8 m in Izmeny Bay, and in Yuzhno-Kurilskaya Bay, the highest tides are about 1.65 m.

Each intertidal subzone is characterized by own communities. The distribution of species in the intertidal communities was provisionally estimated by eye. The types of communities were distinguished and named by

dominant (frequently belt-forming) species of macrobenthos (see Plates 1–11). For example, the *Littorina sitkana* community means an assemblage of macrobenthos dominated by a gastropod species *Littorina sitkana*; the *Chthamalus dalli* + *Littorina sitkana* community – dominated by two species with similar values of biomass, barnacle *Chthamalus dalli* and a gastropod species *Littorina sitkana*; the *Fucus evanescens* community – dominated by the brown alga *Fucus evanescens*, etc.

Quadrates of metal frames were randomly placed within each of the three intertidal subzones (upper, middle, and lower subzones) and within the boundaries of the distinguished communities along each transect. We chose two or three samples (quadrates) from each community. Quadrates of 100 and 250 cm^2 were put on soft sediments, and those of 100, 250, and 500 cm^2 were put on the rocky reefs. When organisms were small and exhibited nearly uniform distribution, we used smaller frames, as opposed to samplings in the communities of individuals with fairly large body size or species that were rarely distributed and not so common. On hard substrata, macrobenthos had to be collected by scraping in quadrates, until all organisms were removed from the surface of substratum. On soft sediments, the upper layer of sediment (approximately 10 cm thick) was being gotten out from quadrate. To remove sediments from the macrobenthic samples, we used a set of six 200 mm diameter aluminium soil sieves with mesh sizes 10 mm, 7 mm, 5 mm, 3 mm, 2 mm and 1 mm. Samples were sieved over 1 mm mesh size *in situ*.

Not all species were quantified. Qualitative samples of macrobenthos were taken outside the quadrates, but, as a rule, within the boundaries of the distinguished communities. Some species had to be collected outside the boundaries of communities, but included in the list of macrobenthos of the intertidal zone of Kunashir Island (see Appendix). Plants and animals had to be collected by hands in these samples. This method was used for determining presence/absence of species without definition of their density and biomass. Some species are rare, and all species of macrobenthos cannot get in quadrates. Besides, it wasn't always possible to quantify macrobenthos within some microhabitats, for instance, such as crevices, holes or under boulders. On the other hand, some species dwell in association with other species as epibionts, and it wasn't always possible to quantify them. Therefore we attempted to survey species composition of the intertidal macrobenthos as far as possible more fully, using the quantitative and qualitative samples (see Plate 14).

Each quantitative or qualitative sample was recorded separately. All the taxonomic groups of macrobenthos were registered. Specimens from the quantitative samples, after drying on a filter paper, weighed using pharmaceutical scales accurate to 10 mg; large seaweeds and seagrasses were weighed on a technical balance accurate to 1 g. The data obtained were extrapolated for 1 m^2. The biomasses presented in the paper, including shells of mollusks and the other skeletal structures of animals, are provided as wet weights. Some dominant species was identified in the field works. The collected material was fixed in 75% alcohol or 4% formalin and taken to the laboratory for identification. In 1991, 5 transects were performed, 68 quantitative and 6 qualitative samples of macrobenthos had to be collected in the intertidal zones of Kunashir Island, and also 147 specimens of algae and seagrasses had to be preserved on herbarium sheets.

Data analysis

The description of vertical distribution and species composition of the intertidal macrobenthos in Pervukhina Bay, on reef 1 km southward of Cape Kruglyy and on beach 1.5 km eastward of Golovnino Village in Izmeny Bay, in central part of Yuzhno-Kurilskaya Bay, and on Cape Rogacheva was conducted by the quantitative and qualitative samples collected in 1991. Besides, a general conclusion about the distribution and species composition of the intertidal macrobenthos all over Kunashir Island were made on a basis of the materials of expeditions in 1951, 1954, 1955 (qualitative samples) (Kussakin, 1956, 1957), 1963, 1964 (quantitative samples) (Kussakin and Tarakanova, 1977), 1987, 1988 (Kostina, 1991), and 1991 (present data) (quantitative and qualitative samples).

A general list of species found on all locations studied of Kunashir Island was compiled by the results of qualitative and quantitative sampling of expeditions in 1951, 1954, 1955, 1963, 1964, 1987, 1988, and 1991 to represent composition of the intertidal biota of Kunashir Island as a whole and also to determine the

biogeographical composition of macrobenthos (see Appendix). Our records (expedition of 1991), early published literature data on expedition of 1951–1988 (Kussakin, 1956, 1957; Kussakin and Tarakanova, 1977; Kostina, 1991), and as well as reference to the macrophytic and macrofauna species of these expeditions (Zinova and Perestenko, 1974; Kussakin, 1975) not mentioned in previous publications were used to put together the list of the macrobenthic plants and animals of the intertidal zone of Kunashir Island. Besides, literature data on various groups of animals were also used to clarify the taxonomic position and the geographical area within which species can be found: Porifera (Khodakovskaya, 2003, 2005), Hydrozoa (Antsulevich, 1992; Sheiko, 2009), Actiniaria (Sanamyan and Sanamyan, 2009), Polychaeta (Buzhinskaja, 2013), Sipuncula (Morozov and Adrianov, 2002), Pantopoda, Leptostraca, and Mysida (Petryashev et al., 2004), Cirripedia (Sessilia) (Poltarukha et al., 2006), Amphipoda (Vassilenko, 2006; Budnikova and Bezrukov, 2008; Labay, 2013), Cumacea (Tzareva et al., 2013), Decapoda (Hayashi and Kim, 1999; Komai, 1999; Asakura and Watanabe, 2005; Kim et al., 2006; Marin, 2014), Isopoda (Golovan and Malyutina, 2010), Mollusca on the whole (Kantor and Sysoev, 2005), Gastropoda (Chernyshev and Chernova, 2005; Gulbin, 2009a, b, 2010a, b), Bivalvia (Lutaenko and Noseworthy, 2012), Bryozoa (Dick et al., 2005; Grischenko et al., 2007; Grischenko and Foster, 2012), Asteroidea (Shin, 1995; Byrne et al., 1997), Holothuroidea (Stepanov et al., 2012; Panina and Stepanov, 2013), Ascidiacea (Lejeusne et al., 2011). Additionally, check-lists of species and some monographs on the fauna and flora of the Russian Far Eastern seas and adjacent waters were used to clarify the species' biogeography and taxonomy (Kussakin et al., 1997; Fauna and Ecosystems…, 2004; Ilustrated Keys…, 2009, 2010, 2012; Check-List of Species…, 2013). Moreover, concerning the systematics, nomenclature, and detailed distribution of algae and seagrasses, we follow M. D. Guiry and G. M. Guiry (2016), and about classification and distribution of fishes, we follow R. Froese and D. Pauly (2016).

Biogeographical characteristics are given for each organisms of the species rank on a base of the patterns of the species distribution in geographic space. For the eastern and western coasts, the data of 1951–1964 and ones of 1987–1991 (only 1991 for western coast) are represented separately (see Appendix), since changes of the biogeographical composition of macrobenthos could take place for 30–40 years. Unfortunately, on the southern coast, only single transect was done in 1991, and 20 transects were performed from 1951 to 1964 (Table 1). Besides, 187 species were found from 1951 to 1964, and only 27 species were found in 1991 (polychaete *Alitta brandti*, a gastropod species *Cerithiopsis stejnegeri*, and fish *Opisthocentrus ocellatus* had not been detected during previous surveys). Therefore, we combined biogeographical data of 1951–1964 with those of 1991 for Izmeny Bay.

In the present paper, we use biogeographical terminology widely accepted in Russian biogeographical literature (Kussakin, 1975, 1990; Lutaenko, 1993; Kafanov and Kudryashov, 2000; and others). The temperate waters of the Northern Hemisphere are called boreal, and those of the Southern Hemisphere – notal.

1. Pacific species:

A. Low-boreal species are limited in their southward distribution by a line of Wonsan (North Korea) – Sado Island and Cape Inubo (western and eastern coasts of Honshu, respectively) – Point Conception (California) and in their northward distribution by Cape Patience (Cape Terpeniya, the east-central Sakhalin Island) – Ekateriny Strait (between Iturup and Kunashir islands) on the Asian coast and at Strait of Juan de Fuca (Puget Sound, Washington) on the American coast (amphi-Pacific species are distributed in low-boreal waters of both the Asian and American coasts).

B. High-boreal species are distributed mainly from a line of Cape Patience – Ekateriny Strait – Strait of Juan de Fuca to Bering Strait.

C. Widespread boreal species are distributed mainly from a line of Wonsan – Sado Island and Cape Inubo – Point Conception to Bering Strait, i.e., inhabit the Pacific low-boreal and high-boreal waters.

D. Subtropical-boreal species are distributed mainly from the northern part of Taiwan, Kyushu Island, Yellow Sea, and the southern part of the Korean Peninsula on the Asian coast and from the southern part of the

Baja California Peninsula on the American coast to Bering Strait. Subtropical-low-boreal species are limited in their northward distribution by low-boreal waters.

2. Species of the Northern Hemisphere:

A. Amphi-boreal species are distributed in both the Pacific and Atlantic temperate waters (on the eastern coast of the Atlantic Ocean, the boreal species are limited in their southward distribution mainly by the southern part of English Channel, but frequently including the Bay of Biscay and the western coast the Iberian Peninsula up to the Strait of Gibraltar, and in their northward distribution by Cape Kanin Nos (Barents Sea) and the western coast of Spitsbergen; on the western coast of the Atlantic Ocean, the boreal species spread from Cape Hatteras (North Carolina) to Davis Strait and Denmark Strait).

B. Boreal-arctic species inhabit the Pacific and/or Atlantic temperate waters and the Arctic seas.

C. Subtropical-boreal/low-boreal species are distributed in the subtropical and boreal/low-boreal waters both of the Pacific and Atlantic oceans (Atlantic subtropical species spread mainly from South Carolina, the northwestern Africa (mainly Morocco), and the Mediterranean Sea to the southern boundary of the Atlantic boreal waters, at the same time, there is not definite the northern boundary of the distribution of Atlantic low-boreal species on the American coast, and on the Europen coast, these species spread approximately from the southwestern part of the Iberian Peninsula to English Channel).

3. Worldwide distributed species:

A. Tropical-boreal/low-boreal and tropical-subtropical species are distributed from the tropic waters of World Ocean (Indo-Pacific, tropical eastern Pacific (from the southern tip of the Baja California Peninsula in the north to the northern Peru in the south), and tropical Atlantic (in the western Atlantic, these species distribute from Florida and Gulf of Mexico through Caribbean and along the South America's Atlantic coast to Cape Frio (Rio de Janeiro state), and in the eastern Atlantic, they extend along the African coast from Cape Blanco (Mauritania) to the Tigres Peninsula (Angola)) to the boreal/low-boreal/subtropical waters of the Pacific and/or Atlantic oceans.

B. Subtropical/tropical-boreal-Arctic species are distributed from the subtropical or tropical waters to the Arctic seas.

C. Anti-tropical species are distributed mainly in the temperate waters (partly in subtropical waters) of the Northern and Southern hemispheres and the polar regions, but show a geographical delimitation of the distribution pattern in tropical regions (also known as bipolar species).

D. Notal-tropical-boreal/low-boreal/subtropical species are distributed from the temperate waters of the Southern Hemisphere to boreal/low-boreal/subtropical waters of the Northern Hemisphere (in the northward, temperate waters of the Southern Hemisphere are limited mainly by the southern part of South America, the southernmost part of Australia, and New Zealand).

E. Species of almost world-wide distribution are called panoceanic (cosmopolitan) species for animals and multizonal species for plants.

A cluster analysis was carried out in order to group 23 sampling locations of Kunashir Island having similar the species composition of the intertidal macrobenthos. Hierarchical cluster analysis was performed using the StatSoft STATISTICA 6.0 (the clustering is based on Euclidean distance with using Ward's method). Qualitative data (lists of species) have been used (namely presence/absence of species in each of 23 locations) from 1951 to 1991 to construct a dendrogram. Study of the intertidal macrobenthos of Kunashir Island was carried out during 40 years, but each of 22 locations (1–9 and 11–23) has been investigated in a certain year or at least within 12–13 years (Table 1). Whereas in 1.5 km eastward of Golovnino Village (Izmeny Bay), the intertidal investigations were conducted in 1991 at one of the same location studied in 1951–1963 (location 10), therefore, in this location, the species compositions of macrobenthos of 1951–1963 and one of 1991 were used separately for cluster analysis (10a – 1951–1963 and 10b – 1991; see Fig. 3), since changes of the composition of the intertidal biota could occur for 30–40 years.

Results

Rocky intertidal zone

A reef southward of Cape Kruglyy (location 2) is an indented flat rocky platform with a slight slope. The coast is weakly protected and exposed to almost permanent wave action. The vertical stratification of communities is well marked.

The upper intertidal subzone: communities found in this subzone tend to exhibit a uniform species composition. There are community dominated by a gastropod species *Littorina sitkana* and community dominated by barnacle *Chthamalus dalli* (Table 2). Algae are not typical for these communities. The upper part of this subzone and partially supratidal zone are occupied by the *L. sitkana* belt. The *Littorina* biomass makes up to 99% of the total macrobenthic biomass, and this sea snail is the most numerous species (more than 90 thousand individuals m^{-2}). The following animals are also found in the community: species of gastropods *Falsicingula kurilensis* and *Lottia pelta*, an isopod species *Gnorimosphaeroma noblei*, and barnacle *Ch. dalli*. Immediately below the *L. sitkana* belt, the upper subzone is occupied by the *Ch. dalli* community with a low total biomass of macrobenthos (up to 240 g wet wt m^{-2}) including *Ch. dalli* itself and other species (species of gastropods *Nucella heyseana*, *L. sitkana*, *Lottia persona*, and others).

The belt-forming community dominated by the red alga *Gloiopeltis furcata* is found on the boundary between the upper and middle subzones. *F. kurilensis* and *L. sitkana* are the most abundant animals (Table 3).

The middle intertidal subzone: fucoids are dominant in this subzone. The *Silvetia babingtonii* community forms its own belt. Dominant species makes up about 95% of the total macrobenthic biomass (Table 4). *Littorina sitkana* dominates among animals in the community. In the *Fucus evanescens* + *Silvetia babingtonii* community, biomasses of the dominant and subdominant species make up to 90% of the total macrobenthic biomass. As well as in the *Gloiopeltis furcata* community, *L. sitkana* and *Falsicingula kurilensis* are dominant among animals. A gastropod species *Nassarius fraterculus* and the amphipod species *Apohyale bassargini*, *Ampithoe kussakini*, and *Spasskogammarus spasskii* frequently occur.

Besides, the community dominated by the brown alga *Analipus japonicus* can be found in the upper part of the middle intertidal subzone, in which species composition is very poor. Dominant species makes up to 95% of the total macrobenthic biomass (Table 4).

In the belt-forming community dominated by the calcareous red alga *Corallina pilulifera*, the other algae are not found (Table 6). Species of gastropods *F. kurilensis*, *N. fraterculus*, and *L. sitkana*, and also the amphipod species *A. kussakini* and *Parallorchestes ochotensis* are abundant. Dominant species makes up to 80% of the total macrobenthic biomass.

A community dominated by the red alga *Neorhodomela aculeata* is one of the most diverse communities in the middle subzone. Apart from *N. fraterculus*, *F. kurilensis*, *L. sitkana*, and *P. ochotensis*, the hermit crab *Pagurus middendorffii* frequently occurs. *Sargassum miyabei*, *Neorhodomela munita*, and *C. pilulifera* are almost equally represented among algae (Table 6).

A community dominated by the green alga *Chaetomorpha moniligera* can be frequently found in the middle subzone. The total biomass of macrobenthos is quite low (up to 560 g wet wt m^{-2}), and species of gastropods (*F. kurilensis*, *Nucella heyseana*, *Nassarius fraterculus*, and *L. sitkana*) are abundant in the community (Table 8).

In sites, on the boundary between the middle and lower subzones, where rocks are splited by spaces filled with sand, the community dominated by the surfgrass *Phyllospadix iwatensis* occurs with insignificant the total biomass of macrobenthos (up to 800 g wet wt m^{-2}) (Table 10). Polychaetes and some species of gastropods are more abundant groups of macrobenthos in the grass habitat. The diverse polychaetes (*Chone teres*, *Nereis vexillosa*, *Naineris jacutica*, *Glycinde armigera*, *Capitella capitata*, *Harmothoe imbricata*, and others) dwell in rhizomes and roots of *Phyllospadix*. Species of gastropods *N. fraterculus*, *N. heyseana*, *Lottia*

persona, *Mitrella burchardi*, *Cryptonatica hirasei*, and *Homalopoma sangarense* are conspicuous inhabitants of the *Phyllospadix* bed. Also small fish *Alectrias alectrolophus* frequently occurs in the tide puddles.

The lower intertidal subzone: the belt-forming communities dominated by the brown algae *Sargassum miyabei* and *Sargassum thunbergii* with rather rich species composition of macrobenthos are typical for this subzone (Table 11). The *S. miyabei* biomass makes up about 60% of the total macrobenthic biomass, whereas biomasses of accompanying species of the red algae – *Neorhodomela aculeata* and *Mastocarpus pacificus* – amount about 30% of the total biomass. Species of gastropods *Nassarius fraterculus*, *Falsicingula kurilensis*, *Littorina sitkana*, *Homalopoma sangarense*, and *Pusilina plicosa*, and the amphipod species *Ampithoe kussakini* and *Apohyale bassargini*, the isopod species *Idotea ochotensis* and *Holotelson tuberculatus* are frequently found in the community. In the *S. thunbergii* community, the dominant species makes up more than 95% of the total macrobenthic biomass. The species composition in the community is slightly different from that in the *S. miyabei* community. The amphipod species *A. bassargini*, *Ischyrocerus* sp., and *Caprella cristibrachium*, and a gastropod species *F. kurilensis* are the most numerous here.

Rocky-bouldery intertidal zone

A reef in Pervukhina Bay (location 1) is a flat rocky platform with scattered boulders under a high precipice. The coast is exposed to wave action. The vertical stratification of the communities is well marked.

The upper intertidal subzone: the settlements of *Chthamalus* and *Littorina* are rarefied, and they do not always form a continuous belt. The *Littorina sitkana* community occupies the sides of boulders. The biomass of *Littorina* is very low (45 g wet wt m^{-2}). The *Chthamalus dalli* community is situated just below the *Littorina* belt and also characterized by low value of the macrobenthic biomass (up to 200 g wet wt m^{-2}) (Table 2).

The middle intertidal subzone: the upper part of this subzone is occupied by the *Silvetia babingtonii* and *Fucus evanescens* communities with the rare patches of the green algae *Cladophora opaca*, *Chaetomorpha moniligera*, and *Ulva lactuca*. These communities are characterized by lower values of biomasses (up to 3390 g wet wt m^{-2}) than those on the rocky reef southward of Cape Kruglyy, although *S. babingtonii* and *F. evanescens* also make up about 95% of the total biomass of macrobenthos (Table 4). Species of gastropods *Falsicingula kurilensis* and *Littorina sitkana*, a bivalve mollusk *Turtonia minuta* and an amphipod species *Ampithoe kussakini* are the most numerous in the fucoid communities.

The red and green algae communities occur below the fucoids. Communities dominated by the red algae *Laurencia nipponica*, *Chondrus pinnulatus* and *Mastocarpus pacificus* are found on Kunashir Island only on the reef in the Pervukhina Bay. In the latter community, biomass of the calcareous red alga *Corallina pilulifera* is about a third of the *M. pacificus* biomass (Table 6).

The *Neorhodomela aculeata* community is widespread on Kunashir Island. Species composition of the community is fairly diverse, but sea anemone *Cnidopus japonicus*, the hermit crab *Pagurus middendorffii*, an isopod species *Idotea ochotensis*, and the amphipod species *Ampithoe* sp. and *Caprella* sp. mainly prevail among animals, and the red alga *Rhodomela sachalinensis* is abundant among macrophytes (Table 6).

Communities dominated by the green algae *Ulva lactuca* and *Cladophora opaca* + *Chaetomorpha* sp. are usually situated below the *N. aculeata* community. In the *Ulva* community, algae *Mazzaella japonica*, *Sargassum miyabei*, and germs of *Saccharina* sp. dominate, whereas in the *Cladophora* community, *U. lactuca* prevails. The most abundant invertebrates of the communities are species of gastropods *Lottia persona* and *F. kurilensis*, and an amphipod species *A. kussakini* (Table 8).

On the boundary between the middle and lower subzones, where reef is splited by spaces filled with sand, thickets of *Phyllospadix iwatensis* spread out (Table 10). Among macrophytes, only the red alga *C. pilulifera* occurs, and species composition of animals is very diverse in this belt-forming community. However, biomass of animal species does not exceed 4% of the total macrobenthic biomass. Numerous species of polychaetes (*Chone teres*, *Nereis vexillosa*, *Naineris jacutica*, *Nereis zonata*, and others) dwell in roots and rhizomes of *Phyllospadix*. Species of gastropods *Nucella heyseana*, *Epheria turrita*, *Haloconcha minor*, *Mitrella burchardi*,

and some others, species of bivalves *Protothaca euglypta*, *Mysella kurilensis litoralis*, and *Turtonia minuta*, the isopod species *I. ochotensis*, *Holotelson tuberculatus*, *Gnorimosphaeroma noblei*, and *Cleantiella isopus*, the amphipod species *Pontogeneia* sp., *Pontogeneia kondakovi*, and others, sea urchin *Strongylocentrotus intermedius*, sea anemone *C. japonicus*, the hermit crab *P. middendorffii*, chiton *Boreochiton granulatus*, and the many other groups of invertebrates also can be found in the *Phyllospadix* beds.

The lower intertidal subzone: in the upper part of this subzone, the *Sargassum miyabei* and *Scytosiphon lomentaria* belt-forming communities with almost equal the total macrobenthic biomass (about 4500 g wet wt m^{-2}) occur (Table 11). The thalli of *Sargassum* provide habitats for a diverse fauna (species of gastropods *Falsicingula kurilensis*, *Pusilina plicosa*, and *Volutharpa ampullacea*, the helmet crab *Telmessus cheiragonus*, the amphipod species *Ampithoe kussakini*, *Ampithoe* sp., and *Apohyale bassargini*, and species of bivalves *Turtonia minuta* and *Protothaca euglypta*, and others). Among macrophytes, only the red alga *Neorhodomela aculeata* and the brown alga *Sargassum thunbergii* are found in the *Sargassum* community. While in the *S. lomentaria* community, there are many different species of algae (the green alga *Ulva lactuca*, the brown algae *S. miyabei*, *Costaria costata*, *Chordaria flagelliformis*, *Saundersella simplex*, and *Ralfsia fungiformis*, and the red algae *Tichocarpus crinitus*, *Laurencia nipponica*, *Lomentaria hakodatensis*, *Palmaria stenogona*, and *Polysiphonia morrowii*, and many others), although, on the whole, macrobenthos is poorer in species composition as compared to the *S. miyabei* community.

The community dominated by the brown macroalga *Saccharina* sp. forms a distinct belt just below the *Sargassum* and *Scytosiphon* belts on the side towards the open sea. Biomass of *Saccharina* makes up more than 99% of the total macrobenthic biomass. Only several species of animals are found, and a gastropod species *F. kurilensis*, an amphipod species *Ampithoe volki*, and polychaete *Typosyllis* sp. are frequently recorded in the community (Table 11).

Bouldery-sandy intertidal zone

A cape in Yuzhno-Kurilskaya Bay (location 19) is a site of scattered boulders and rocky blocks among the sand. The coast is weakly protected from wave action. The vertical distribution of the communities exhibits insignificant stratification, and patchy distribution of macrobenthos is typical for this intertidal zone. Macrobenthos is represented by a rich infauna of soft-sediment habitats, and population of hard substrata is slightly poorer than that in the rocky and rocky-bouldery intertidal zones.

The upper intertidal subzone: the barnacle community dominated by *Chthamalus dalli* + *Semibalanus cariosus* is found on the rocky blocks and boulders (Table 2). The community is characterized by fairly high biomass of macrobenthos (3425 g wet wt m^{-2}). Species of gastropods *Littorina sitkana* and *Nucella heyseana*, polychaete *Typosyllis adamanteus*, insect larvae, and other invertebrates are found, but plants are absent in the barnacle community.

The boundary between the upper and the middle subzones is occupied by the *Gloiopeltis furcata* + *Chthamalus dalli* community. A numerous amphipod species *Corophium* sp. and a gastropod species *L. sitkana* are frequently observed here (Table 3).

The middle intertidal subzone: communities dominated by the brown algae *Silvetia babingtonii*, *Fucus evanescens*, and *Analipus japonicus* are found on the sides of the rocky blocks and boulders. The dominant species make up not less than 90% of the macrobenthic biomass. The communities have different species compositions, but comprise only a few species. In the *Silvetia* community, *Chthamalus dalli*, *Littorina sitkana*, and an amphipod species *Apohyale bassargini* prevail. In the *Fucus* community, *L. sitkana* and an isopod species *Gnorimosphaeroma noblei* predominate. In the *Analipus* community, a gastropod species *Nucella heyseana*, and small specimens of polychaetes and amphipods are abundant (Table 5).

The *Corallina pilulifera* community can be found on the broad horizontal surfaces of boulders and rocky blocks. Biomass of the dominant species makes up about 95% of the total macrobenthic biomass. Polychaete *Nereis pelagica*, a gastropod species *Falsicingula kurilensis*, an isopod species *Synidotea lata*, the helmet crab *Telmessus cheiragonus*, and others invertebrates are abundant in the community (Table 7).

Communities dominated by the red algae *Tichocarpus crinitus*, *Odonthalia corymbifera*, and *Palmaria marginicrassa* are found on Kunashir Island only in the Yuzhno-Kurilskaya Bay. Young germs of *Saccharina* sp. are quite a few in these red algal communities. Sponge *Halichondria panicea* usually occurs on the boulders and the red algae and makes up about 35% of the total biomass in the *O. corymbifera* community. Fauna is fairly diverse in the *T. crinitus* community and the *O. corymbifera* community. Hydroids *Abietinaria filicula* and *Eudendrium vaginatum*, the amphipod species *Caprella* sp. and *Caprella cristibrachium*, the helmet crab *T. cheiragonus*, and other groups of invertebrates are abundant in thickets of algae. Only a few species of animals are found in the *P. marginicrassa* community, however (Table 7).

Among communities of the red algae, there is the *Mazzaella parksii* community with fairly high species richness. Species of gastropods *Lottia persona*, *F. kurilensis*, and *L. sitkana*, hydroid *Obelia longissima*, polychaete *N. pelagica*, an amphipod species *A. bassargini*, species of bivalves *Panomya* sp., *Musculus laevigatus*, and *Turtonia minuta* mainly prevail. Among algae, only *C. pilulifera* is observed (Table 7).

Communities dominated by the green algae can be found in spaces between patches of the red algae. In the *Blidingia minima* community, macrobenthos is poor (only the brown alga *Analipus japonicus* and barnacle *Ch. dalli* can be frequently found). In the *Chaetomorpha melagonium* community and the *Ulva lactuca* community, fauna also represents by a few species (Table 8).

Colonies of hydroid *Abietinaria filicula* are anchored to the surfaces of boulders and rocky blocks shaded from sunlight. Only young germs of *Saccharina* sp. occur in the *Abietinaria filicula* community among macrophytes (Table 9). Among animals, a gastropod species *Lottia pelta*, ascidians, bryozoans *Cryptosula zavjalovensis* and *Celleporella hyalina*, sea anemone *Cnidopus japonicus*, and polychaete *N. pelagica* are dominated. Besides *A. filicula*, hydroids *Abietinaria thuiarioides*, *Halecium lucium*, *Eudendrium vaginatum*, *Sertularia robusta*, *Campanularia volubilis*, and others can be found in this community. Numerous sedentary polychaetes Sabellidae are found attached to the undersides of boulders in the tide puddles. In this community, polychaete *Naineris jacutica* and sea anemone *Oulactis orientalis* are dominated, and plants are absent.

On the boundary between the middle and lower subzones, *Phyllospadix iwatensis* forms the dense beds on the sand among the rocky blocks and boulders (Table 10). Most animals inhabit rhizomes and roots of *Phyllospadix*. Sea anemone *O. orientalis*, polychaetes *N. jacutica*, *Chone teres*, *Eudistylia suavis*, *Nereis vexillosa*, and *Pseudopotamilla occelata*, species of gastropods *N. heyseana* and *L. sitkana*, and the helmet crab *T. cheiragonus* prevail quantitatively.

The lower intertidal subzone: the *Saccharina* sp. belt stretches in this subzone. The total biomass of the *Saccharina* community is more than 100 kg wet wt m^{-2}, and the dominant species makes up more than 99% of the community biomass (Table 11). Polychaetes (*Nereis pelagica*, *Chone* sp., and others), sea spiders, hydroids *Eudendrium vaginatum* and *Campanularia volubilis* are found into holdfasts of *Saccharina*, whereas amphipods (*Parallorchestes ochotensis*, *Apohyale bassargini*, and others) inhabit thalli of the alga.

Sandy intertidal zone

A beach in Izmeny Bay (location 10) is protected from a strong wave action. Species diversity is poorer as compared to that in the many other areas studied. At the Golovino Village, the intertidal zone is exposed to domestic sewage and wastewater from seafood processing.

The upper intertidal subzone: macrobenthos is not found here.

The middle intertidal subzone: it is occupied by the belt-forming community dominated by a gastropod species *Batillaria cumingii*. This community includes only several animal species, and the dominant species makes up about 90% of the macrobenthic biomass (Table 12).

The lower intertidal subzone: areas from the lowest part of the middle to the upper part of the lower intertidal subzones are occupied by the belt-forming community dominated by the eelgrass *Zostera japonica*. Macrobenthos is fairly rich. Infaunal bivalve mollusk *Ruditapes philippinarum*, polychaetes *Nereis vexillosa* and *Abarenicola pacifica*, and also epifaunal sea snails *Batillaria cumingii* and *Nassarius fraterculus* are the most abundant in the *Zostera* beds (Table 12). Eelgrass beds also provide shelter for shallow-water fish

Opisthocentrus ocellatus.

The *Zostera marina* belt is widespread in the lower part of the lower subzone. *R. philippinarum* is dominated by biomass among animals (Table 12). Polychaetes (*Alitta brandti*, *Naineris jacutica*, *Glycinde armigera*, *Chone* sp., *Nereis pelagica*, and others), which are found burrowing into sand or dwelling in roots of eelgrass, prevail in the species composition of the *Z. marina* community. On leaves of *Zostera*, species of gastropods *Lirularia iridescens*, *Cerithiopsis stejnegeri*, and *Pusilina plicosa* dwell, and *B. cumingii* and *Nassarius multigranosus* live on the sand flat.

Tide pool

Cape Rogacheva (location 23): the middle subzone: on a flat reef, there is a tide pool about 20 m diameter and about 30 cm depth, separated from the open sea by a rocky terrace and protected from a strong wave action. The vertical stratification of communities is observed only on the walls of the tide pool, whereas the communities may exhibit a patchy distribution on a bottom of the tide pool.

At the level of boundary of transition of the walls of the tide pool into the top part of reef, the belt-forming community dominated by *Littorina sitkana* and the *Chthamalus dalli* + *Littorina sitkana* community occur (Table 13). Species composition of animals composes of a few species, and algae are not found in these communities. The red alga *Gloiopeltis furcata* community is situated along the edge of the tide pool, below belts of *Littorina* and *Chthamalus*.

A belt of fucoids with more diverse species composition than in communities of top of the tide pool is situated below the *G. furcata* community, on the walls of the pool and scattered boulders along the pool's walls. In the *Silvetia babingtonii* community with the rare patches of *Fucus evanescens*, biomass of algae is many times higher than the animal biomass, and the dominant species makes up more than 97% of the total biomass of macrobenthos (Table 14). Just below the *S. babingtonii* community, the *Fucus evanescens* community occurs. Macrobenthic species of the communities are diverse (species of gastropods *L. sitkana*, *Nucella freycinetii*, *Lottia persona*, *Mitrella burchardi*, and others, an amphipod species *Apohyale bassargini*, barnacle *Ch. dalli*, a bivalve mollusk *Mytilus trossulus kussakini*, the hermit crab *Pagurus middendorffii*, the isopod species *Gnorimosphaeroma noblei* and *Idotea ochotensis*, and other invertebrates). *L. sitkana* dominates among animals. A community dominated by the brown alga *Analipus japonicus* occurs below the fucoid belt.

Macrobenthos with mix of various species is typical for the bottom of the tide pool. Seagrasses, the red and green algae are dominant. A total projective cover of bottom by *Corallina* and *Phyllospadix* estimated visually is up to 90%. The calcareous red alga *Corallina pilulifera* community forms a dense carpet on the bottom of the pool. *Corallina* makes up about 95% of the total macrobenthic biomass (Table 15). In addition to quantitatively recorded species, the red algae *Halosaccion hydrophorum* and *Corallina officinalis*, the brown alga *Leathesia marina*, the green alga *Ulva lactuca*, and others are also found in the *Corallina* community. The animal biomass is almost twenty times less than the plant biomass. Mollusks *Falsicingula kurilensis* and *Littorina sitkana* are the most numerous dwellers.The *Phyllospadix iwatensis* community is typical for sites of the sand accumulation on the rocky substratum. The dominant species makes up about 95% of the total macrobenthic biomass (Table 15). Animals are diverse, but many species have a low biomass in this community. Both infaunal animals (polychaetes *Naineris jacutica*, *Nereis pelagica*, *Lumbrineris japonica*, and others, sipunculid worm *Phascolosoma* (*Physcosoma*) *agassizii*, species of nemerteans *Tubulanus punctatus*, and a bivalve mollusk *Protothaca euglypta*) and epifaunal forms (the helmet crab *Telmessus cheiragonus*, the hermit crabs *Pagurus middendorffii*, *Pagurus hirsutiusculus*, and *Pagurus brachiomastus*, the wrinkled crab *Dermaturus mandtii* and the king crab *Paralithodes brevipes*, species of gastropods *Mitrella burchardi*, *Buccinum mirandum mirandum*, and others, sea anemone *Cnidopus japonicus*, sponge *Halichondria panicea*, chiton *Boreochiton granulatus*, Pantopoda, and many other invertebrates) can be found in this community. The red algae communities *Neodilsea yendoana*, *Pterosiphonia bipinnata*, *Neorhodomela aculeata* + *Neorhodomela oregona*, and *Mazzaella parksii* exhibit patchy distributions. In the communities, flora is composed of only several species, whereas fauna is very diverse (Table 16). In the *N. yendoana* community,

an isopod species *Idotea ochotensis*, an amphipod species *Apohyale bassargini*, and the hermit crab *Pagurus middendorffii* are frequently found. In the *P. bipinnata* community, barnacle *Chthamalus dalli*, polychaete *N. pelagica*, an isopod species *Cliamenella fraudatrix*, the amphipod species *A. bassargini* and *Pontogeneia* sp. are the most numerous species. Dominance of *Pontogeneia* sp. and mollusks *Littorina sitkana* and *Nucella heyseana* is typical for the *N. aculeata* + *N. oregona* community, whereas *A. bassargini* and mollusks *Hiatella arctica*, *L. sitkana*, and *Falsicingula kurilensis* prevail in the *M. parksii* community. *Chaetomorpha linum* and *Chaetomorpha melagonium* are dominant species in the communities of the green algae. Though the total biomasses are different in the communities, species compositions of macrobenthos are almost identical. Abundant animal species include *L. sitkana*, *A. bassargini*, and *F. kurilensis* (Table 16). On the seaside of the tide pool, at the edge of the terrace, *Alaria ochotensis* forms the dense beds. Macrobenthos of this belt-forming community is rather diverse in species composition (Table 11). Barnacles *Semibalanus cariosus* and *Chthamalus dalli*, species of gastropods *Nucella freycinetii*, *Lottia pelta*, and *Littorina sitkana*, species of bivalves *Mytilus trossulus kussakini* and *Hiatella arctica*, an amphipod species *Parallorchestes ochotensis*, and polychaete *Nereis pelagica* are the most abundant animals in the community. Many the red algae species (*Pterosiphonia bipinnata*, *Mazzaella parksii*, *M. japonica*, *Constantinea subulifera*, *Neoptilota asplenioides*, *Mastocarpus pacificus*, *Masudaphycus irregularis*, *Odonthalia annae*, and others) vegetate on the seaside of the rock reef.

Discussion

Biogeographical composition of macrobenthos

In the intertidal zones of Kunashir Island, 164 plant and 399 animal species are found. Red algae dominate among plants, and polychaetes, species of gastropods, and the amphipod species prevail among animals. Biogeographical composition of macrobenthos is typical for low-boreal subregion of the Pacific boreal region. Low-boreal and widespread boreal species are mainly dominant (on the eastern coast – 18 and 46% (1951–1964), 15 and 48% (1987–1991), respectively; on the western coast – 22 and 42% (1951–1964), 22 and 48% (1991), respectively; on the southern coast – 24 and 32% (1951–1991), respectively). After the mid-20th century, the proportions of cold-water species (boreal-Arctic and high-boreal species) of the total number of species found on the eastern and western coasts of Kunashir Island declined as compared to those of 1991 by 3–4%, that can be attributed to the consequences of global warming. At the same time, percentage of warm-water species (low-boreal species and species distributed from tropical or subtropical regions to low-boreal waters) decreased by 5% on the eastern coast. It should be noted increase of amount of geographically widespread species (species are able to tolerate a wide range of temperature conditions) by 4–8% on both the eastern and western coasts of Kunashir Island (Fig. 2).

Biogeographical structure of macrobenthos on various coasts of Kunashir Island is somewhat different. Warm-water species are more abundant in the intertidal zones of Izmeny Bay and the Sea of Okhotsk coast as compared to those of the Pacific coast of Kunashir Island (low-boreal and tropical/subtropical-low-boreal species make up in sum 28 (1951–1964) and 23% (1987–1991) of the total number of species found on the eastern coast, 33 (1951–1964) and 32% (1991) – on the western coast, and 42% (1951–1991) – on the southern coast of Kunashir Island). This fact is related to the circulation of waters of the Soya Warm Current (SWC). Flows of SWC distribute off the Sea of Japan through La Pérouse/Soya Strait in the south part of the Sea of Okhotsk, flowing southeastward along the Hokkaido coast and South Kurile Islands with a maximum influx during summer and a minimum influx during winter (Takizawa, 1982; Ohshima et al., 2001; Matsuyama et al., 2006), giving warm-water features to the intertidal biota of Kunashir Island, especially its southern and western coasts (Bobkov, 2004). One minor branch of SWC flows near Cape Shiretoko through Kunashirskiy/Nemuro Strait and Izmeny Strait/Notsuke Channel out to the Pacific Ocean, but does not pass in

Yuzhno-Kurilskiy/Southern Kuril Strait. The other minor branch, passing through Ekateriny Strait/Kunashiri Channel, fills only the most northern part of Yuzhno-Kurilskiy Strait and also enters the Pacific Ocean. Perhaps this could explain why SWC may have no significant environmental impact on the biogeographical composition of the intertidal macrobenthos on the Pacific coast of Kunashir Island.

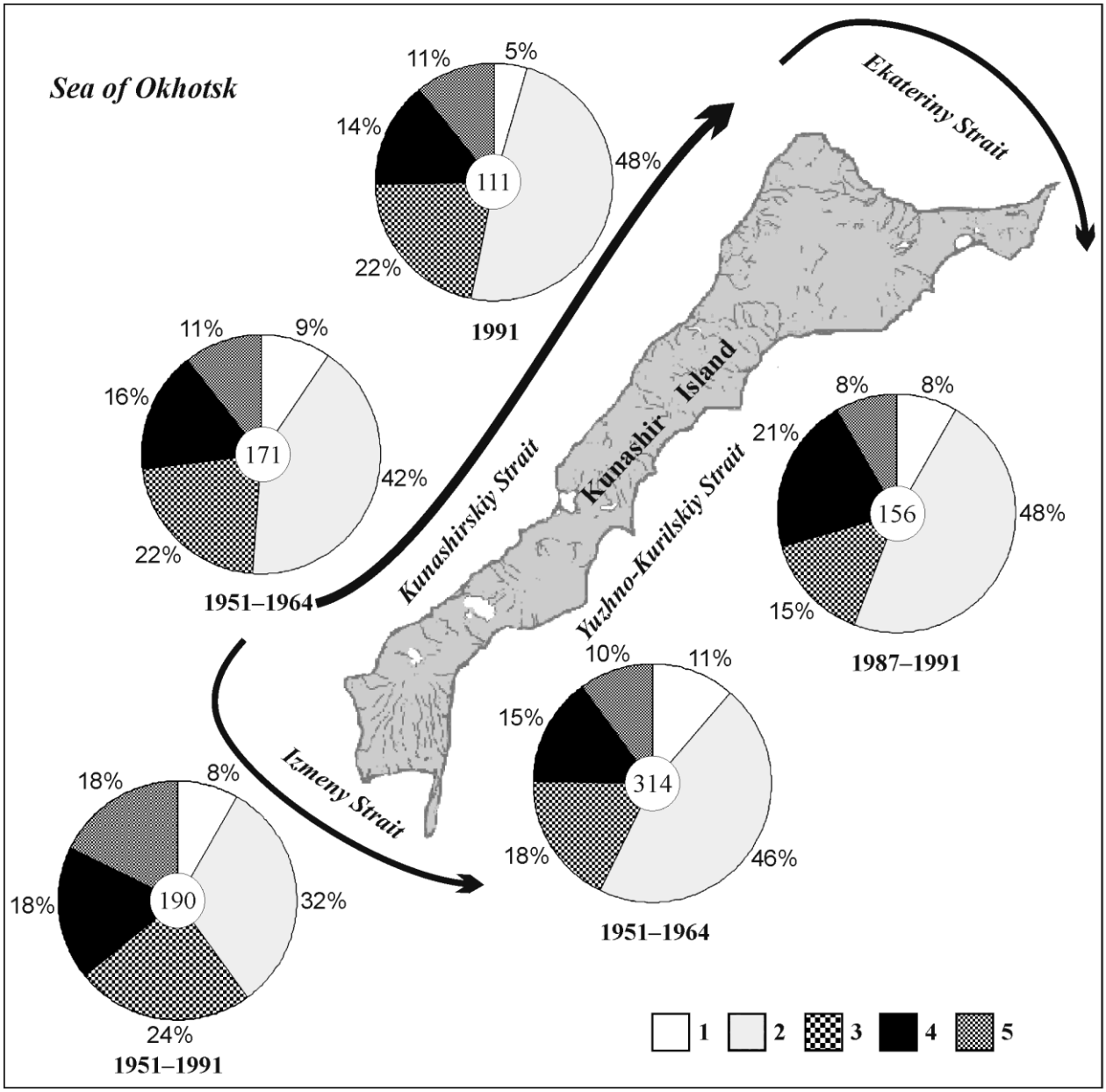

Figure 2. Biogeographical structures of macrobenthos in the intertidal zones of Kunashir Island. 1 – relatively cold-water high-boreal and boreal-Arctic species, 2 – widespread boreal species and species common in both subtropical and boreal waters, 3 – low-boreal species, 4 – widespread species, 5 – subtropical-low-boreal, tropical-low-boreal, and tropical-subtropical species. The branches of the Soya Warm Current are shown by arrows; the total number species are shown in the center of the circles.

The summer sea surface temperature (SST) is important factor determining distribution of marine organisms on the shelf of the Kurile Islands, including the intertidal zone. During winter, latitudinal gradients of the SST are smoothed, and the February isotherms of −1...1°C of SST pass throughout the entire Kurile Ridge, from the south to north (Atlas of Sakhalin Region, 1967), so, in winter, the temperature conditions of the South Kurile Islands are approximately equal with those of the North Kurile Islands. In July–October, the SWC becomes fully developed and approaches the South Kurile Islands, whereas during the other months, the SWC is weak. Besides, in winter, Yuzhno-Kurilskiy Strait is filled with cold waters of the Sea of Okhotsk and Oyashio Current (Takizawa, 1982; Bobkov, 2004). Thus, changes in the proportion of cold- and warm-water species take place in accordance with variations of the long-term mean SST in the intertidal zones of the Kurile Islands during a warm season (Kussakin, 1975, 1976). The maximal number of warm-water species had been found in Izmeny Bay (42% in total, see Fig. 2), that conforms to peculiarities of hydrological conditions of the area (SST reaches 27ºC in August), while not more than 33 and 28% warm-water species inhabit the western and eastern coasts of Kunashir Island, respectively. The number of cold-water species (boreal-Arctic and high-boreal species) is not very different on the coasts and makes up to 8, 9, and 11% on the southern, western and eastern coasts of Kunashir Island, respectively.

Occurence of a large number of warm-water sea stars (*Aphelasterias japonica*, *Lethasterias fusca*, *Distolasterias elegans*, *Lysastrosoma anthosticta*, and others) is a peculiar feature of the western coast of Kunashir Island (see Appendix). The other warm-water species of animals, such as the isopod species *Dynoides dentisinus* and *Tylos granuliferus*, species of bivalves *Decorifer matusimanus* and *Teredo navalis*, and sea cucumber *Apostichopus japonicus* are also found only here. Among warm-water algae, tropical-low-boreal the belt-forming species *Sargassum thunbergii* occurs only in the intertidal zones of the western coast of Kunashir Island. The maximal number of species of subtropical- and tropical-low-boreal complexes is found on the southern coast, in the Izmeny Bay intertidal zone. The brown algae of Sargassaceae, *Sargassum pallidum* and *Stephanocystis hakodatensis*, the hippolytid shrimps *Eualus leptognathus* and *Spirontocaris ochotensis mororani*, the isopod species *Paranthura japonica* and *Cymodoce japonica*, mollusks *Notoacmea concinna*, *N. schrenckii*, *Littorina brevicula*, *Macoma incongrua*, and *Nuttallia obscurata*, and sea star *Asterina pectinifera* are found only in Izmeny Bay. Some of species are the dominant species in communities, for instance, subtropical-low-boreal *Batillaria cumingii*, on the southern coast Kunashir Island.

Among Decapoda, Isopoda, Echinodermata, and Mollusca, the number of warm-water species (subtropical-, tropical-low-boreal, and low-boreal species) is about 50% (see Appendix), because these more or less motile invertebrates probably can overwinter migrating from the intertidal zone to deeper water. Warm-water species are absent altogether among Bryozoa, and there are very few of these species among Porifera, Hydrozoa, and also macrophytes, i.e., sessile organisms. Kunashir Island probably is the northern border of distribution of many warm-water intertidal species of macrobenthos in the Far Eastern Seas (Kussakin, 1956).

Distribution of macrobenthos

On Kunashir Island, the vertical distribution pattern of macrobenthos is typical for that of a low-boreal intertidal zone with a maximum tidal range about 1.5–1.8 m. As a rule, poor, almost devoid of vegetation, communities dominated by *Chthamalus dalli* and *Littorina sitkana*, sometimes having a belt-like distribution pattern, are typical for the upper subzone of the rocky and bouldery intertidal zones. The *Gloiopeltis furcata* community can be found on the boundary of the upper and middle subzones.

Fucoid assemblages develop in the middle subzone. The upper part of this subzone is occupied by the *Silvetia babingtonii* community, often forming a belt, and below it, patches of the *Fucus evanescens* community are found. The *F. evanescens* community does not form its own belt, in contrast to the *S. babingtonii* community. The macrobenthic biomass in the communities can reach more than 25 kg wet wt m^{-2}. The other algal communities can be found in the lower part of the middle intertidal subzone. The *Corallina*

pilulifera community often occurs in the puddles of residual tidal water and on the bottom of the tide pools. The diverse communities dominated by the red algae (*Neorhodomela aculeata*, *Mazzaella parksii*, *Laurencia nipponica*, *Chondrus pinnulatus*, *Mastocarpus pacificus*, *Tichocarpus crinitus*, *Odonthalia corymbifera*, *Palmaria marginicrassa*, and others) and the green algae (*Chaetomorpha moniligera*, *Ch. melagonium*, *Ulva lactuca*, *Cladophora opaca*, *Blidingia minima*, and others) form mosaics of patches among of fucoids and *Corallina*. The *Analipus japonicus* community is also typical for the middle intertidal subzone. The *Phyllospadix iwatensis* community, with a diverse animal population due to a large number of infaunal forms, occurs in sites where rocky bottom is splited by spaces filled with sand or inhabits soft-sediment substrata between boulders. The *C. pilulifera* and *Ph. iwatensis* thickets are also extended to the lower intertidal subzone.

In 1951, on the rocky sites of the eastern coast of Kunashir Island, the belt-forming community dominated by the red alga *Neosiphonia japonica* was distinguished in the lower part of the upper intertidal subzone and in the middle intertidal subzone, and the belt-forming community dominated by the brown alga *Chordaria chordaeformis* was observed in the middle intertidal subzone and in the upper part of the lower intertidal zone. At the same time, only patches of the *Ch. chordaeformis* community or some small solitary bushes of the alga were seen on the rocky surfaces of the western coast of Kunashir Island (Kussakin, 1956, 1977).

Large laminarian algae, especially *Alaria ochotensis* and *Saccharina* sp., form the dense beds in both the lower intertidal subzones and subtidal fringe, mainly on the eastern coast of Kunashir Island. In these communities, the total macrobenthic biomass can reach 100 kg wet wt m^{-2}. At the same time, communities dominated by the brown algae *Sargassum miyabei*, *S. thunbergii*, and *Scytosiphon lomentaria* with rather high species richness prevail in the intertidal zones of the western coast of Kunashir Island. In 1963–1964, in the lower intertidal subzone, the belt-forming community dominated by *Neorhodomela aculeata* + *Phyllospadix iwatensis* was observed on rocks split by spaces filled with sand, on coast of Sea of Okhotsk, and the *Arthrothamnus bifidus* + *Odonthalia floccosa* belt was found in the bouldery intertidal zone, on the Pacific coast of Kunashir Island (Kussakin and Tarakanova, 1977). In some areas, where the rocky and bouldery intertidal zones undergo the abrasive effects of winter ice, and perennial species cannot survive (including brown macroalgae of Laminariales), in summer, an annual green alga *Acrosiphonia duriuscula* develops (Kussakin et al., 1974; Kussakin and Tarakanova, 1977). In the lower subzone of the bouldery intertidal zone, the communities are often distributed in a form of patches, and, on the whole, the vertical stratification of the communities is less marked, than in the rocky subzone, although, the dominant species of the lower intertidal communities are basically similar on both rocks and boulders.

The sandy intertidal zone differs from the rocky and bouldery intertidal sites by the macrobenthic composition and distribution. On sandy beaches exposed to wave action and composed of clean, perfectly sorted sand, communities are usually poor, macrophytes and the other attached forms are absent. The upper part of such beaches and supratidal zone are inhabited by the amphipods, mainly by Talitridae, a mysid species *Archaeomysis grebnitzkii*, other motile invertebrates, and the larval forms of the various insects. In the lower part of the beaches, fauna is also not rich (there are mainly infaunal forms: species of bivalves *Spisula sachalinensis*, *Protothaca euglypta*, polychaete *Abarenicola pacifica*, nemerteans, and others), but its biomass reaches 1 kg m^{-2}, mainly due to development of mollusk *S. sachalinensis*. Fauna of silted-sandy beaches of the western and eastern coasts of Kunashir Island is like that of the sandy intertidal zone (Kussakin, 1956; Kussakin and Tarakanova, 1977). In the silted-sandy and sandy intertidal zones of Izmeny Bay, there are the communities dominated by *Zostera japonica* and *Batillaria cumingii*, which are not found in the other locations of Kunashir Island.

In the tide pools, a belt distribution of communities is observed only on the walls of the pools, whereas a patchy distribution of communities is typical for the bottom of the these pools. The tide pools are characterized by a high level of biodiversity of macrobenthos due to development of a complex of organisms, which is typical in both the lower intertidal subzone and subtidal zone (diverse red algae, brown algae of Laminariales and Sargassaceae, surfgrass *Phyllospadix iwatensis*, sponges *Halichondria panicea* and

Sycettusa nemurensis, hydroids *Abietinaria inconstans*, *A. filicula*, *Eudendrium vaginatum*, *Sertularella spinosa*, and *Sertularia similis*, sea slug *Coryphella athadona*, bryozoans *Tricellaria ternata* and *Celleporella hyalina*, sea stars *Asterina pectinifera*, *Aphelasterias japonica*, *Leptasterias* (*Eoleptasterias*) *kussakini*, and *L.* (*E.*) *similispinis*, sea urchin *Strongylocentrotus intermedius*, and others invertebrates, diverse ascidians and fishes).

In areas of gasohydrothermal vents, there are some changes in the qualitative and quantitative composition of the intertidal macrobenthos as compared to other areas of Kunashir Island. The intertidal macrobenthos of the Goryachiy Plyazh is under the influence of the thermal springs of Mendeleeva Volcano. The springs are observed among the rocks, boulders, and sand as the seeps of a hot water (up to 80°C) containing hydrogen sulfide. The macrobenthos is absent in the sites directly influenced by high temperature (above 40°C) and impoverished in the vicinity of the gasohydrothermal vents and seeping volcanic waters. Two tide pools up to 1.5 m depth with seeps of volcanic fluid and a sulfuric acid stream are on the Goryachiy Plyazh. In one of the pools (sea water temperature is 5°C in March and 25°C in October), there are only a few species of macrobenthos: algae *Chaetomorpha melagonium* covering with thick layer of diatoms, and *Fucus evanescens*, barnacles *Semibalanus cariosus* and *Chthamalus dalli*, sea anemone *Diadumene lineata*, and the isopod species *Synidotea lata* and *Tecticeps glaber*. But a population density of *D. lineata* reaches above 2000 individuals m^{-2}. In the others areas of Kunashir Island, *D. lineata* is not found. In the tide pool with the sea water temperature from 25°C to 60°C in different seasons, macrobenthos is absent, and only the algal-bacterial mats covered the walls of the pool are near hydrothermal vents (see Plates 12, 13). In the stream-bed, only the solitary algae *F. evanescens* and *Ulva prolifera* dwell. At the same time, there are no marked changes of the intertidal communities in the sites of volcanic springs characterized by the sea water temperature below 10–15°C and, in general, the species composition and distribution of the intertidal biota are ordinary for the rocky intertidal zones of Kunashir Island (Kostina, 1991).

Long-term changes of macrobenthos in Izmeny Bay

In 1991, survey of the intertidal zone was carried out in Izmeny Bay in 1.5 km eastward of Golovnino Village in one of the same transect as in 1963. In 1963, most of the middle intertidal subzone was occupied by the belt-forming community dominated by a bivalve mollusk *Ruditapes philippinarum* with biomass of the dominant species 114 g wet wt m^{-2}, and species of gastropods *Batillaria cumingii* and *Neptunea arthritica*, and a bivalve mollusk *Macoma incongrua* were the subdominant species (about 60–85 g wet wt m^{-2}). In 1991, *B. cumingii* became the dominant species of the community (445.6 g wet wt m^{-2}), and biomass of *R. philippinarum* reduced seven times as compared to 1963 (15.6 g wet wt m^{-2}). Besides, a reduction of species richness took place in this community (in 1963 – 11 species, in 1991 – 5). In 1991, biomass of macrobenthos increased to a third of that observed in the 1963 in this community (329.0 g wet wt m^{-2} and 503.6 g wet wt m^{-2} in 1963 and 1991, respectively). Polychaetes *Abarenicola pacifica* and *Hediste japonica* were found in this community only in 1991.

In 1963, 26 macrobenthic species were found in the *Zostera japonica* belt-forming community, whereas in 1991 there were only 20 species. Besides, the brown alga *Chordaria* sp., the amphipod species *Allorchestes malleolus*, *Ampithoe* sp., and *Lepidepecreum* sp., an isopod species *Gnorimosphaeroma noblei*, gastropod species *Falsicingula kurilensis*, and a bivalve mollusk *Turtonia minuta* were found only in 1991. Biomass of macrobenthos increased in this community in 1991 as compared to 1963 (1280.5 g wet wt m^{-2} and 1942.1 g wet wt m^{-2} in 1963 and 1991, respectively).

In both 1963 and 1991, 15 plant and animal species were found in the *Zostera marina* belt-forming community. However, there were only six mutual species: eelgrass *Z. marina*, species of gastropods *Batillaria cumingii* and *Nassarius multigranosus*, a bivalve mollusk *Macoma incongrua*, and polychaetes *Nereis vexillosa* and *Abarenicola pacifica*. Some species of polychaetes (*Alitta brandti*, *Naineris jacutica*, *Glycinde armigera*, *Chone* sp., and *Nereis pelagica*) and two species of gastropods (*Cerithiopsis stejnegeri* and *Pusilina plicosa*) were found only in 1991. Biomass of macrobenthos increased a little bit in this community (2384.0 g

wet wt m^{-2} and 2422.8.1 g wet wt m^{-2} in 1963 and 1991, respectively). Besides change of the species composition of the *Z. japonica* and *Z. marina* communities, change of the subdominant species took place (*M. incongrua* – in 1963 and *Ruditapes philippinarum* – in 1991).

The intertidal zone is exposed to wastewater from seafood processing and domestic sewage near Golovnino Village. Over 30 years, the quantitative and qualitative changes of the intertidal biota took place in this area. After 1963, the species richness of macrobenthos reduced, and changes in the species composition of communities occurred, whereas the total macrobenthic biomass increased in the communities. It fully conforms to the observed earlier tendency on the other South Kurile Islands, when eutrophication of biotopes takes place and increase of the total macrobenthic biomass is observed, and at the same time, species richness steadily declines under the effect of weak and moderate organic pollutions (Kussakin and Tsurpalo, 1999).

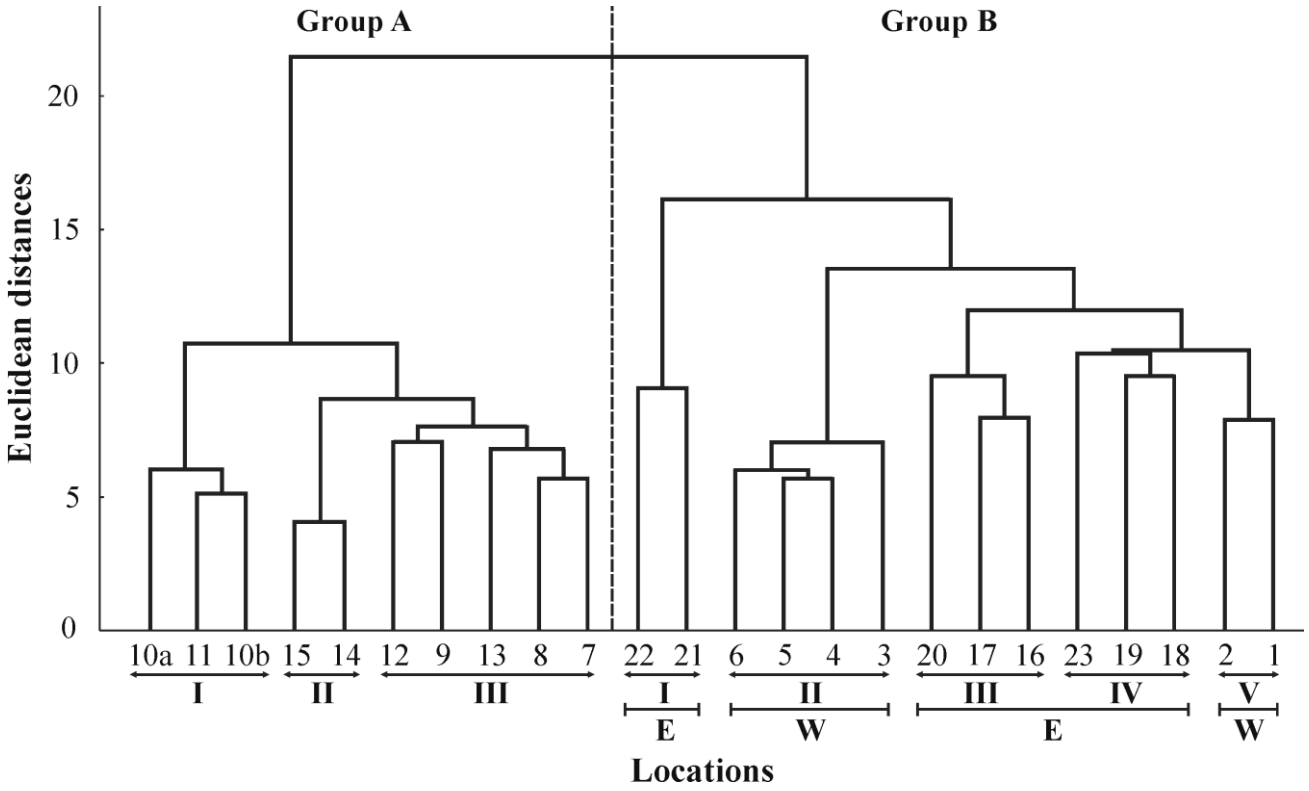

Figure 3. Dendrogram of similarity in the macrobenthic species composition between studied intertidal locations of Kunashir Island. Group A – southern coast: subgroup I includes beach eastward of Golovnino Village (10a – 1951–1963, 10b – 1991) and the northern part of Veslovskoe Lake (11); subgroup II includes Cape Veslo (14) and eastern coast of Veslovskiy Peninsula (15); subgroup III includes Cape Paltusov (7), beach eastward of Cape Paltusov (8), beach westward of Golovnino Village (9), Veslovskoe Lake (12), and western coast of Veslovskiy Peninsula (13). Group B – western (W) and eastern (E) coasts: subgroup I includes Golovnina Bay (21 – Cape Yuzhno-Kurilskiy and 22 – Cape Sukacheva); subgroup II includes Sernaya Bay (3) and Alekhina Bay (4 – boulders, 5 – rocks, and 6 – rocky blocks and boulders); subgroup III includes Sernovodskaya Bay (16 – Cape Chetverikova and 17 – Cape Vodopadnyy) and northeastern part of Yuzhno-Kurilskaya Bay (20); subgroup IV includes Goryachiy Plyazh (18), central part of Yuzhno-Kurilskaya Bay (19), and Cape Rogacheva (23); subgroup V includes Pervukhina Bay (1) and reef southward of Cape Kruglyy (2).

Comparative remarks

The sampling locations of the Kunashir Island intertidal zones are combined in two major groups by similarity of the macrobenthic species composition. The first major group (group A) comprises all locations of the silted-sandy and sandy intertidal zones in Izmeny Bay on the southern coast of Kunashir Island. Locations of the western and eastern coasts characterized mainly by the intertidal zones of hard substrata are combined in the second major group (group B) (Fig. 3).

Group A is further divided into three distinct subgroups. Subgroup I includes locations of the most inner part of Izmeny Bay (1.5 km eastward of Golovnino Village and the northernmost part of Veslovskoe Lake (lagoon) on Veslovskiy Peninsula). These sites are characterized by a weak wave action, silted sand covered gravel, admixute of H_2S in the sand, seawater freshening, and very wide belt dominated by eelgrasses *Zostera japonica* and *Z. marina* with a rather rich composition of animals and plants in the lower part of middle intertidal subzone and lower intertidal subzone. On beach, 1.5 km eastward of Golovnino Village, the macrobenthic species compositions of 1951–1963 and that of 1991 are combined together, although the species richness of macrobenthos reduced in 1991 as compared to 1963.

In locations westward of Golovnino Village up to the Cape Paltusov and on the western coast of Veslovskiy Peninsula, including most part of Veslovskoe Lake, i.e., towards the westernmost and southernmost coasts of Izmeny Bay (subgroup III), the seagrass communities gradually disappear in the intertidal zone and spread in the upper subtidal zone probably due to increasing wave action, decreasing silting of sands, and various other factors affecting the intertidal biota. However, settlements of *Zostera* can be found in lagoon of Cape Paltusov and Veslovskoe Lake (Kussakin, 1956; Kussakin and Tarakanova, 1977). In locations of subgroups I and III, macrobenthos is not found in most of the upper intertidal subzone, only associations dominated by the gastropod species *Batillaria cumingii* and *Littorina sitkana*, and barnacle *Chthamalus dalli* sometimes occur. Westward of Golovnino Village and on the southwestern coast of Veslovskiy Peninsula, where the *Zostera* belt spreads in the upper subtidal zone, community dominated by the green alga *Ulva linza* can be found in the middle intertidal subzone and the upper part of the lower intertidal subzone.

Locations of subgroup II (Cape Veslo and eastern coast of Veslovskiy Peninsula) are wave-exposed sandy beaches composed of clean sand, sometimes with admixute of gravel. The macrobenthic species composition is poor and uniform here. These locations are wholly devoid of any intertidal macrophytes and inhabited by mainly motile small crustaceans (the mysid, isopod, and amphipod species) and polychaetes, dwelling, as a rule, in the supratidal zone (Kussakin, 1956; Kussakin and Tarakanova, 1977).

Group B includes the eastern and western coasts of Kunashir Island often exposed to wave action (especially eastern coast). Communities dominated by *Chthamalus dalli* and *Littorina sitkana* are typical for the upper intertidal subzone, and communities dominated by fucoid algae (*Silvetia babingtonii* and *Fucus evanescens*) and the brown alga *Analipus japonicus* prevail in the middle intertidal subzone on the eastern and western coasts. Five subgroups characterized by certain species compositions of macrobenthos can be distinguished within group B. Locations of subgroup I are entrance rocky capes of Golovnina Bay on the eastern coast of Kunashir Island. However, entrance capes of Sernovodskaya Bay (Cape Vodopadnyy and Cape Chetverikova), also located on the eastern coast of Kunashir Island, are combined with the northeastern part of Yuzhno-Kurilskaya Bay (subgroup III), because at Cape Vodopadnyy and in the northeastern part of Yuzhno-Kurilskaya Bay, sampling was carried out in the bouldery intertidal zones with underlying sand. In locations of subgroups I and III, the belt-forming communities dominated by the red alga *Corallina pilulifera* and seagrass *Phyllospadix iwatensis* are widespread throughout the lower intertidal subzones, and laminarian algae are poorly developed. Moreover, sedentary and sessile forms (many species of mollusks (*Littorina sitkana*, *L. squalida*, *Falsicingula kurilensis*, *Nassarius fraterculus*, *Buccinum mirandum mirandum*, and others), tube-building polychaete worms (*Circeis spirillum*, *Eudistylia suavis*, and others), sea anemones (*Oulactis orientalis* and *Charisea saxicola*), and others) predominate on the rocky reefs in Golovnina Bay (Cape Yuzhno-Kurilskiy and Cape Sukacheva) and on Cape Chetverikova (Sernovodskaya Bay). At Cape

Vodopadnyy of Sernovodskaya Bay and in the northeastern part of Yuzhno-Kurilskaya Bay, there are both animals inhabiting boulders (chiton *Mopalia schrencki*, polychaetes *Lepidonotus squamatus* and *Harmothoe imbricata*, shield limpet *Lottia pelta*, crude whelk *Buccinum percrassum*, sea snail *Mitrella burchardi*, a bivalve mollusk *Protothaca euglypta*, sponge *Halichondria panicea*, and diverse sea anemones) and infaunal invertebrates, as a rule, polychaetes (many species of *Nereis*, *Cirratulus cirratus*, *Capitella capitata*, *Eulalia viridis*, *Autolytus caterinkae*, and *Proceraea prismatica*) (Kussakin and Tarakanova, 1977).

Subgroup IV comprises various locations of the Pacific coast of Kunashir Island (disposed close to each other, rocky intertidal zone of Goryachiy Plyazh and blocky-bouldery intertidal zone of central part of Yuzhno-Kurilskaya Bay, and also tide pool on rocky reef of Cape Rogacheva) probably due to the fact that they are inhabited by organisms characteristic mainly for hard substrata. Besides, unlike subgroups I and III, laminarian algae, mainly *Alaria ochotensis* and *Saccharina* sp., form extensive belts in the lower intertidal subzones of locations of subgroup IV.

Subgroup II comprises all the sampling locations of Alekhina and Sernaya bays disposed close to each other on the western coast of Kunashir Island and characterized mainly by hard substrata in the upper part of the intertidal zone and spread of sands in the lower part of the intertidal zone. Besides, this area is under the influence of solfataric-hydrothermal springs of the Golovnina Volcano (Alekhinskaya groups of thermal springs), some of which issue on the Sea of Okhotsk coast of Kunashir Island (Zharkov, 2014). Subgroup V includes rocky reef of Pervukhina Bay and reef southward of Cape Kruglyy on the western coast of Kunashir Island. In the lower intertidal subzones, the belt dominated by large laminarian algae is almost absent on the western coast of Kunashir Island, with the exception of some locations (for example, in Pervukhina Bay). The lower intertidal subzone of Alekhina and Sernaya bays are occupied by the red alga *Neorhodomela aculeata* community (Kussakin and Tarakanova, 1977), and the communities dominated by the brown algae *Sargassum miyabei*, *S. thunbergii*, and *Scytosiphon lomentaria* are widespread in Pervukhina Bay and on the reef southward of Cape Kruglyy.

The intertidal biota of Kunashir Island has many common features with that of the neighboring Shikotan Island by composition and patterns of distribution of the macrobenthic communities. The maximal similarity can be observed between the eastern coast of Kunashir Island and the northwestern coast of Shikotan Island, however, some distinctions can be made between patterns of macrobenthic communities of these islands. So, the belt-forming community dominated by the brown algae *Chordaria chordaeformis* do not occurs on Shikotan Island. The brown alga *Saundersella simplex*, that is epiphyte on *Ch. chordaeformis*, *Scytosiphon lomentaria*, and *Analipus japonicus*, common on the Sea of Okhotsk coast of Kunashir Island, was not found on Shikotan Island, but also it was observed neither on the Pacific coast of Kunashir Island nor in Izmeny Bay. The brown seaweed *Fucus evanescens* often forms dense belts on the coasts of Shikotan Island with a weak wave exposure, whereas in similar biotopes of Kunashir Island, *Fucus* shows patchy distribution pattern. Contrariwise, the *Silvetia babingtonii* belt-forming community is more distributed on Kunashir Island than on Shikotan Island. The soft crab *Hapalogaster grebnitzkii* is frequently found in the rocky intertidal zone of Shikotan Island and is not found on Kunashir Island, while porcelain crab *Pachycheles stevensii*, rock crab *Cancer gibbosulus*, and an isopod species *Cleantiella isopus* are found on hard substrata of Kunashir Island and are not found on Shikotan Island (Kussakin, 1956, 1977).

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Table 1. Sampling locations in the intertidal zones of Kunashir Island.

N	Location	Latitude, N°	Longitude, E°	Substratum	Month (or season), year	Number of transects
1	Northern part of Pervukhina Bay	44.074647	145.745755	Rocky reef with scattered boulders	July 1991	1
2	1 km southward of Cape Kruglyy	43.996992	145.650139	Rocky reef	July 1991	1
3	Northern part of Sernaya Bay	43.955560	145.591243	Rocky reef; sand in the lower part of the intertidal zone	Summer 1964 (Kussakin, Tarakanova, 1977)	1
4	Northern part of Alekhina Bay	43.921864	145.533807	Boulders; sand in the lower part of the intertidal zone	June–August 1951, December 1954, Summer 1964 (Kussakin, 1957; Kussakin, Tarakanova, 1977)	1
5	Northern part of Alekhina Bay	43.919628	145.528356	Rocky reef; boulders in the upper part and sand in the lower part of the intertidal zone	June–August 1951, Summer 1964 (Kussakin, 1957; Kussakin, Tarakanova, 1977)	1
6	Nameless cape in the southern part of Alekhina Bay	43.912284	145.509677	Rocky blocks and boulders	June–August 1951 (Kussakin, 1957)	1
7	Cape Paltusov	43.723973	145.443117	Sandy-silted beaches	June–August 1951 (Kussakin, 1956, 1957)	3
8	3.5 km eastward of Cape Paltusov, Izmeny Bay	43.729067	145.474101	Gravelly beach with admixture of sand and shell; silted sand in the lower part of the intertidal zone	June–August 1951 (Kussakin, 1957)	2
9	0.5 km westward of Golovnino Village in Izmeny Bay	43.735021	145.510750	Sandy beach; silted sand in the lower part of the intertidal zone	June–August 1951, Summer 1963 (Kussakin, 1956, 1957; Kussakin, Tarakanova, 1977)	1
10	1.5 km eastward of Golovnino Village in Izmeny Bay	43.732680	145.542164	Sandy beach with admixture of shell, gravel and silt	June–August 1951, December 1954, Summer 1963 (Kussakin, 1956, 1957; Kussakin, Tarakanova, 1977), July 1991	2 (1951–1963) and 1 (1991)
11	Northern part of Veslovskoe Lake (lagoon) on Veslovskiy Peninsula, Izmeny Bay	43.730994	145.550695	Sand with admixture shell in the upper part, silted sand in the middle part, and silted sand with admixture of shell and gravel in the lower part of the intertidal zone	June–August 1951, December 1954, Summer 1963 (Kussakin, 1956, 1957; Kussakin, Tarakanova, 1977)	4
12	Head of Veslovskoe Lake (lagoon) on Veslovskiy Peninsula, Izmeny Bay	43.701971	145.549391	Silt, occasional silted sand	June–August 1951, Summer 1963 (Kussakin, 1956, 1957; Kussakin, Tarakanova, 1977)	1

N	Location	Latitude, N°	Longitude, E°	Substratum	Month (or season), year	Number of transects
13	Western coast of Veslovskiy Peninsula, Izmeny Bay	43.683971	145.536205	Sandy beach with admixture of gravel and shell	June–August 1951, Summer 1963 (Kussakin, 1956, 1957; Kussakin, Tarakanova, 1977)	3
14	Cape Veslo	43.653363	145.544831	Sandy beach; sand with admixture of gravel in the lower part of the intertidal zone	June–August 1951 (Kussakin, 1956, 1957)	2
15	Eastern coast of Veslovskiy Peninsula, Yuzhno-Kurilskiy Strait	43.709665	145.559433	Sandy beach; gravel in the lower part of the intertidal zone	June–August 1951 (Kussakin, 1956, 1957)	2
16	Sernovodskaya Bay, Cape Chetverikova	43.884122	145.623848	Rocky reef	June–August 1951, Summer 1964 (Kussakin, 1957; Kussakin, Tarakanova, 1977)	1
17	Sernovodskaya Bay, Cape Vodopadnyy	43.907625	145.669853	Sandy beach with the rare boulders	June–August 1951, Summer 1964 (Kussakin, 1956, 1957; Kussakin, Tarakanova, 1977)	1
18	Goryachiy Plyazh (Hot Beach)	43.992298	145.798745	Rocky reef with scattered boulders	October 1987, March 1988 (Kostina, 1991)	1
19	Nameless cape in central part of Yuzhno-Kurilskaya Bay, 5 km southwesterly of Cape Zavodskoy	44.015185	145.813708	Rocky blocks and boulders on sandy beach	July 1991	1
20	Northeastern part of Yuzhno-Kurilskaya Bay	44.028451	145.854392	Scattered boulders on the silted sand with admixture of shell	June–August 1951, January 1955, Summer 1963 (Kussakin, 1956, 1957; Kussakin, Tarakanova, 1977)	3
21	Golovnina Bay, Cape Yuzhno-Kurilskiy	44.021152	145.877268	Rocky reef	June–August 1951, July, December 1954, January 1955, Summer 1963 (Kussakin, 1957; Kussakin, Tarakanova, 1977)	3
22	Golovnina Bay, Cape Sukacheva	44.070554	145.874329	Rocky reef	June–August 1951, Summer 1963 (Kussakin, 1957; Kussakin, Tarakanova, 1977)	2
23	Cape Rogacheva	44.183787	146.045066	Rocky reef	August 1991	1

Table 2. Density (N, individuals m^{-2}) and biomass (B, g wet wt m^{-2}) of macrobenthos in the upper intertidal subzone on the rocky, rocky-bouldery, and blocky-bouldery substrata.

Taxa	Taxonomic group*	Pervukhina Bay (location 1)				Cape Kruglyy (location 2)				Yuzhno-Kurilskaya Bay (location 19)	
		Littorina sitkana belt		*Chthamalus dalli* settlings		*Littorina sitkana* belt		*Chthamalus dalli* settlings		*Chthamalus dalli* + *Semibalanus cariosus* settlings	
		N	B	N	B	N	B	N	B	N	B
ANIMALS											
Littorina sitkana	Ga	6700	45.0	5200	30.8	91700	5260.0	5800	27.0	5750	76.5
Chthamalus dalli	Ci	–	–	5700	170.0	900	10.0	5400	125.0	16300	2242.5
Semibalanus cariosus	Ci	–	–	–	–	–	–	–	–	300	895.0
Nucella heyseana	Ga	–	–	–	–	–	–	100	70.0	50	0.4
Falsicingula kurilensis	Ga	+	+	–	–	2100	15.0	–	–	–	–
Lottia persona	Ga	–	–	–	–	–	–	300	15.0	–	–
Lottia pelta	Ga	–	–	–	–	100	7.0	–	–	–	–
Gnorimosphaeroma noblei	Is	–	–	–	–	800	7.0	–	–	–	–
Serpulidae	Po		–		–		–		5.2		–
Insecta (larvae)	In	–	–	–	–	–	–	–	–	600	5.0
Polychaeta	Po	–	–	–	–	–	–	–	–	150	4.0
Typosyllis adamanteus	Po	–	–	–	–	–	–	–	–	50	1.5
Cliamenella fraudatrix	Is	–	–	–	–	–	–	200	0.2	–	–
Amphipoda	Am	–	–	–	–	–	–	–	–	50	0.1
Total biomass			45.0		200.8		5299.0		242.4		3425.0

*See Tables 2–16: Och – Ochrophyta, Rh – Rhodophyta, Ch – Chlorophyta, Tra – Tracheophyta, Hy – Hydrozoa, Ac – Actiniaria, Ne – Nemertea, Po – Polychaeta, Si – Sipuncula, Pa – Pantopoda, Ci – Cirripedia, Am – Amphipoda, Cu – Cumacea, De – Decapoda, Is – Isopoda, Le – Leptostraca, In – Insecta, Pol – Polyplacophora, Ga – Gastropoda, Bi – Bivalvia, Bry – Bryozoa, As – Ascidiacea. The sign "+" designates species found within the limits of a considered community, but their abundance is not registered; the sign "–" means that species is not found.

Table 3. Density (N, individuals m^{-2}) and biomass (B, g wet wt m^{-2}) of macrobenthos on the boundary between the upper and middle intertidal subzones, on the rocky and blocky-bouldery substrata. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Cape Kruglyy (location 2)		Yuzhno-Kurilskaya Bay (location 19)	
		Gloiopeltis furcata belt		*Gloiopeltis furcata* + *Chthamalus dalli* belt	
		N	B	N	B
PLANTS					
Gloiopeltis furcata	Rh		805.0		1184.0
Analipus japonicus	Och		–		140.0
Total biomass of plants			805.0		1324.0
ANIMALS					
Chthamalus dalli	Ci	–	–	14880	928.0
Falsicingula kurilensis	Ga	44700	195.0	40	0.2
Littorina sitkana	Ga	8200	110.0	840	2.0
Lottia persona	Ga	200	15.0	–	–
Nucella heyseana	Ga	100	7.0	–	–
Apohyale bassargini	Am	900	3.0	–	–
Nassarius fraterculus	Ga	100	2.0	–	–
Corophium sp.	Am	–	–	2120	2.0
Ampithoe kussakini	Am	100	1.8	–	–
Turtonia minuta	Bi	–	–	40	0.3
Pontogeneia sp.	Am	200	0.2	–	–
Total biomass of animals			334.0		932.5
Total biomass			1139.0		2256.5

Table 4. Density (N, individuals m^{-2}) and biomass (B, g wet wt m^{-2}) of macrobenthos in the middle intertidal subzone on the rocky and rocky-bouldery substrata in the brown algae communities. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Pervukhina Bay (location 1)				Cape Kruglyy (location 2)					
		Silvetia babingtonii belt		*Fucus evanescens* patches		*Silvetia babingtonii* belt		*Fucus evanescens* + *Silvetia babingtonii* patches		*Analipus japonicus* patches	
		N	B	N	B	N	B	N	B	N	B
PLANTS											
Fucus evanescens	Och		71.6		3232.0		–		10440.0		–
Silvetia babingtonii	Och		1508.0		–		5512.8		5680.0		–
Analipus japonicus	Och		–		–		–		–		820.0
Cladophora opaca	Ch		21.6		76.8		–		–		–
Chaetomorpha moniligera	Ch		–		36.8		–		–		–
Corallina pilulifera	Rh		–		+		–		8.8		–
Ulva lactuca	Ch		4.0		5.2		–		–		–
Total biomass of plants			1605.2		3350.8		5512.8		16128.8		820.0
ANIMALS											
Littorina sitkana	Ga	440	3.2	520	6.0	1840	280.0	41120	1388.8	1000	24.0
Falsicingula kurilensis	Ga	1680	5.2	6920	22.0	160	0.4	119240	428.8	3100	10.0
Nassarius fraterculus	Ga	–	–	–	–	120	12.0	1320	66.0	–	–
Nucella heyseana	Ga	+	+	+	+	40	8.8	40	32.0	–	–
Serpulidae	Po		–		–		28.0		–		–
Lottia pelta	Ga	–	–	–	–	80	6.0	–	–	–	–
Lottia persona	Ga	+	+	40	4.8	–	–	–	–	–	–
Chthamalus dalli	Ci	–	–	–	–	120	2.8	–	–	–	–
Apohyale bassargini	Am	+	+	40	0.2	–	–	680	2.8	–	–
Ampithoe kussakini	Am	–	–	360	1.4	–	–	200	1.6	–	–
Turtonia minuta	Bi	360	1.2	320	0.8	–	–	–	–	–	–
Spasskogammarus spasskii	Am	–	–	–	–	–	–	240	0.7	–	–
Cliamenella fraudatrix	Is	–	–	–	–	–	–	–	–	200	0.6
Lottia ochracea	Ga	40	0.4	–	–	–	–	–	–	–	–
Parallorchestes ochotensis	Am	–	–	+	+	–	–	40	0.3	–	–
Allorchestes malleolus	Am	–	–	–	–	–	–	40	0.2	–	–
Total biomass of animals			10.0		35.2		338.0		1921.2		34.6
Total biomass			1615.2		3386.0		5850.8		18050.0		854.6

Table 5. Density (N, individuals m^{-2}) and biomass (B, g wet wt m^{-2}) of macrobenthos in the middle intertidal subzone on the blocky-bouldery substratum in the brown algae communities. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Yuzhno-Kurilskaya Bay (location 19)					
		Silvetia babingtonii belt		*Fucus evanescens* patches		*Analipus japonicus* patches	
		N	B	N	B	N	B
PLANTS							
Silvetia babingtonii	Och		25080.0		–		–
Fucus evanescens	Och		–		16264.0		–
Analipus japonicus	Och		–		–		1400.0
Total biomass of plants			25080.0		16264.0		1400.0
ANIMALS							
Chthamalus dalli	Ci	4640	224.0	–	–	–	–
Nucella heyseana	Ga	+	+	+	+	100	158.0
Littorina sitkana	Ga	280	18.0	160	2.4	–	–
Apohyale bassargini	Am	440	18.0	–	–	100	0.5
Nereis pelagica	Po	–	–	–	–	300	12.4
Amphipoda	Am	–	–	120	4.8	–	–
Typosyllis adamanteus	Po	–	–	–	–	300	4.8
Polychaeta	Po	80	3.2	–	–	–	–
Corophium sp.	Am	–	–	–	–	1600	2.0
Gnorimosphaeroma noblei	Is	–	–	160	0.4	–	–
Ansola angustata	Ga	40	0.2	–	–	–	–
Haloconcha minor	Ga	–	–	80	0.2	–	–
Total biomass of animals			263.4		7.8		177.7
Total biomass			25343.4		16271.8		1577.7

Table 6. Density (N, individuals m^{-2}) and biomass (B, g wet wt m^{-2}) of macrobenthos in the middle intertidal subzone on the rocky and rocky-bouldery substrata in the red algae communities. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Pervukhina Bay (location 1)								Cape Kruglyy (location 2)			
		Neorhodomela aculeata patches		*Laurencia nipponica* patches		*Chondrus pinnulatus* patches		*Mastocarpus pacificus* patches		*Corallina pilulifera* belt		*Neorhodomela aculeata* patches	
		N	B	N	B	N	B	N	B	N	B	N	B
PLANTS													
Laurencia nipponica	Rh		–		3024		–		–		–		–
Chondrus pinnulatus	Rh		–		–		2888		–		–		–
Neorhodomela aculeata	Rh		2748		–		–		–		–		986
Corallina pilulifera	Rh		14		–		–		114		1530		128
Mastocarpus pacificus	Rh		–		–		–		309		–		–
Rhodomela sachalinensis	Rh		780		–		–		–		–		–
Sargassum miyabei	Och		144		94.4		15.2		–		–		211
Neorhodomela munita	Rh		–		–		–		–		–		149.5
Ulva lactuca	Ch		–		122.4		–		–		–		–
Neorhodomela oregona	Rh		–		100.4		–		6.4		–		–
Sphacelaria rigidula	Och		–		76		–		–		–		–
Lithophyllum tumidulum	Rh		–		56		–		–		–		+
Punctaria plantaginea	Och		–		56		–		–		–		–
Phyllospadix iwatensis	Tra		–		–		16		–		–		–
Cladophora opaca	Ch		–		–		–		3.2		–		–
Total biomass of plants			3686		3529.2		2919.2		433.2		1530		1474.5
ANIMALS													
Falsicingula kurilensis	Ga	80	0.3	360	1.2	–	–	2040	6	39700	150	3740	19.9
Nassarius fraterculus	Ga	–	–	–	–	–	–	–	–	2400	97	820	75
Littorina sitkana	Ga	480	2.9	–	–	–	–	–	–	5400	95	240	12
Cnidopus japonicus	Ac	80	36	–	–	–	–	–	–	–	–	–	–
Pagurus middendorffii	De	80	24.4	–	–	–	–	–	–	–	–	140	16
Ampithoe kussakini	Am	80	0.5	–	–	–	–	40	0.1	2200	13.3	120	0.9
Nucella heyseana	Ga	–	–	–	–	–	–	–	–	–	–	40	13
Parallorchestes ochotensis	Am	80	0.3	–	–	–	–	120	0.4	1500	5.3	1820	8.5
Idotea ochotensis	Is	760	8	40	0.4	–	–	–	–	–	–	–	–

Taxa	Taxonomic group	Pervukhina Bay (location 1)								Cape Kruglyy (location 2)			
		Neorhodomela aculeata patches		*Laurencia nipponica* patches		*Chondrus pinnulatus* patches		*Mastocarpus pacificus* patches		*Corallina pilulifera* belt		*Neorhodomela aculeata* patches	
		N	B	N	B	N	B	N	B	N	B	N	B
Polychaeta	Po	–	–	–	–	–	–	–	–	300	8	–	–
Amphipoda	Am	–	–	–	–	400	4.8	–	–	–	–	–	–
Ampithoe sp.	Am	1080	4	120	0.1	–	–	80	0.4	–	–	140	1.2
Caprella sp.	Am	1120	1.7	40	0.3	640	3.2	–	–	–	–	70	0.3
Actiniaria	Ac	–	–	–	–	40	2.8	–	–	–	–	–	–
Lottia pelta	Ga	–	–	–	–	–	–	–	–	–	–	20	2.4
Pontogeneia sp.	Am	400	0.8	680	1.6	–	–	–	–	–	–	60	0.2
Orchomene sp.	Am	–	–	–	–	–	–	–	–	200	1.3	–	–
Schizoplax brandtii	Pol	–	–	–	–	–	–	–	–	100	1	20	1.2
Telmessus cheiragonus	De	–	–	40	0.4	–	–	–	–	–	–	20	1
Ampithoe lacertosa	Am	120	0.9	–	–	–	–	–	–	–	–	100	0.8
Turtonia minuta	Bi	120	0.4	160	0.8	–	–	160	0.8	–	–	40	0.1
Corophium sp.	Am	–	–	–	–	–	–	–	–	100	0.8	–	–
Caprella irregularis	Am	120	0.6	–	–	–	–	–	–	–	–	–	–
Caprella cristibrachium	Am	–	–	240	0.5	–	–	–	–	–	–	140	0.4
Cliamenella fraudatrix	Is	–	–	–	–	–	–	–	–	100	0.5	20	0.2
Caprella bispinosa	Am	–	–	–	–	–	–	–	–	–	–	50	0.2
Nereis zonata	Po	–	–	–	–	–	–	–	–	–	–	60	0.2
Holotelson tuberculatus	Is	–	–	–	–	–	–	–	–	–	–	20	0.2
Ischyrocerus cristatus	Am	–	–	–	–	–	–	–	–	–	–	120	0.2
Pleusymtes sp.	Am	–	–	–	–	–	–	–	–	–	–	100	0.2
Atylus ekmani	Am	–	–	120	0.2	–	–	–	–	–	–	–	–
Pantopoda	Pa	–	–	–	–	–	–	–	–	–	–	20	0.2
Gnorimosphaeroma noblei	Is	40	0.2	–	–	–	–	–	–	–	–	–	–
Ischyrocerus sp.	Am	–	–	–	–	–	–	–	–	–	–	20	0.1
Metopa sp.	Am	40	0.1	–	–	–	–	–	–	–	–	–	–
Total biomass of animals			81.1		5.5		10.8		7.7		372.2		154.2
Total biomass			3767.1		3535.7		2930		441.9		1902.2		1628.7

Table 7. Density (N, individuals m^{-2}) and biomass (B, g wet wt m^{-2}) of macrobenthos in the middle intertidal subzone on the blocky-bouldery substratum in the red algae communities. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Yuzhno-Kurilskaya Bay (location 19)									
		Corallina pilulifera patches		*Tichocarpus crinitus* patches		*Odonthalia corymbifera* patches		*Palmaria marginicrassa* patches		*Mazzaella parksii* patches	
		N	B	N	B	N	B	N	B	N	B
PLANTS											
Tichocarpus crinitus	Rh		–		7444.0		–		–		–
Mazzaella parksii	Rh		–		182.0		–		–		4848.0
Odonthalia corymbifera	Rh		–		–		3200.0		85.0		–
Corallina pilulifera	Rh		1560.0		–		–		–		594.0
Palmaria marginicrassa	Rh		–		–		–		915.0		–
Saccharina sp.	Och		–		2840.0		236.0		42.0		–
Chondrus pinnulatus	Rh		–		–		–		47.0		–
Odonthalia ochotensis	Rh		–		18.8		–		–		–
Total biomass of plants			1560.0		10484.8		3436.0		1090.0		5442.0
ANIMALS											
Halichondria panicea	Sp		–		–		2260.0		–		–
Bryozoa	Bry		–		–		752.0		–		–
Lottia persona	Ga	–	–	–	–	–	–	–	–	800	120.1
Obelia longissima	Hy		–		–		–		–		62.0
Abietinaria filicula	Hy		–		60.0		+		–		+
Nucella heyseana	Ga	100	12.0	40	57.6	–	–	–	–	40	0.8
Nereis pelagica	Po	1000	30.0	–	–	–	–	–	–	1000	20.0
Eudendrium vaginatum	Hy		–		20.0		1.2		–		0.4
Falsicingula kurilensis	Ga	3600	11.0	40	0.1	–	–	–	–	8400	20.0
Caprella sp.	Am	–	–	2280	9.2	80	0.2	–	–	–	–
Synidotea lata	Is	100	8.3	–	–	–	–	–	–	–	–
Telmessus cheiragonus	De	300	7.0	40	0.8	240	8.0	–	–	–	–
Apohyale bassargini	Am	–	–	40	0.4	+	+	–	–	160	7.6
Turtonia minuta	Bi	100	0.5	–	–	–	–	–	–	640	6.4
Littorina sitkana	Ga	–	–	–	–	40	0.8	–	–	440	5.3
Musculus laevigatus	Bi	–	–	–	–	–	–	–	–	200	4.0
Panomya sp.	Bi	–	–	–	–	–	–	–	–	760	3.9

Taxa	Taxonomic group	Yuzhno-Kurilskaya Bay (location 19)									
		Corallina pilulifera patches		*Tichocarpus crinitus* patches		*Odonthalia corymbifera* patches		*Palmaria marginicrassa* patches		*Mazzaella parksii* patches	
		N	B	N	B	N	B	N	B	N	B
Idotea ochotensis	Is	–	–	–	–	240	2.8	–	–	–	–
Typosyllis adamanteus	Po	100	2.5	–	–	–	–	–	–	–	–
Cliamenella fraudatrix	Is	–	–	–	–	–	–	–	–	400	2.4
Modiolus kurilensis	Bi	–	–	–	–	–	–	–	–	120	2.1
Lyonsia sp.	Bi	200	2.1	–	–	–	–	–	–	–	–
Sertularia robusta	Hy		–		–		–		–		2.0
Naineris jacutica	Po	–	–	–	–	40	2.0	–	–	–	–
Sabellidae	Po	100	1.0	40	2.0	–	–	–	–	–	–
Allorchestes malleolus	Am	–	–	–	–	40	2.0	–	–	–	–
Pantopoda	Pa	200	0.5	40	0.3	280	0.8	100	1.0	–	–
Coryphella athadona	Ga	–	–	–	–	–	–	100	1.0	–	–
Orchomenella sp.	Am	100	0.8	–	–	–	–	–	–	–	–
Hiatella arctica	Bi	–	–	–	–	–	–	–	–	40	0.8
Parallorchestes ochotensis	Am	–	–	200	0.8	–	–	–	–	–	–
Nereis sp.	Po	100	0.6	–	–	–	–	–	–	–	–
Caprella cristibrachium	Am	–	–	520	0.2	280	0.6	–	–	–	–
Haloconcha minor	Ga	–	–	–	–	–	–	100	0.5	–	–
Ampithoe sp.	Am	–	–	40	0.4	–	–	–	–	–	–
Abietinaria thuiarioides	Hy		–		+		0.4		–		–
Jassa marmorata	Am	–	–	40	0.3	40	0.1	–	–	–	–
Pontogeneia sp.	Am	–	–	40	0.2	40	0.1	–	–	–	–
Isopoda	Is	–	–	40	0.1	–	–	–	–	–	–
Mytilus trossulus kussakini	Bi	100	0.1	–	–	–	–	–	–	–	–
Total biomass of animals			76.4		152.4		3031.0		2.5		257.8
Total biomass			1636.4		10637.2		6467.0		1092.0		5699.8

Table 8. Density (N, individuals m^{-2}) and biomass (B, g wet wt m^{-2}) of macrobenthos in the middle intertidal subzone on the rocky, rocky-bouldery, and blocky-bouldery substrata in the green algae communities. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Pervukhina Bay (location 1)				Cape Kruglyy (location 2)		Yuzhno-Kurilskaya Bay (location 19)					
		Ulva lactuca patches		*Cladophora opaca* + *Chaetomorpha* sp. patches		*Chaetomorpha moniligera* patches		*Chaetomorpha melagonium* patches		*Blidingia minima* patches		*Ulva lactuca* patches	
		N	B	N	B	N	B	N	B	N	B	N	B
PLANTS													
Chaetomorpha melagonium	Ch		–		–		–		1097.0		–		–
Ulva lactuca	Ch		632.0		190.0		–		270.0		–		320.0
Chaetomorpha moniligera	Ch		–		–		465.0		–		–		–
Cladophora opaca	Ch		–		335.0		–		–		–		–
Blidingia minima	Ch		–		–		–		–		290.0		–
Chaetomorpha sp.	Ch		–		290.0		–		–		–		–
Devaleraea sp.	Rh		–		–		–		–		–		250.0
Mazzaella japonica	Rh		100.0		–		–		–		–		150.0
Analipus japonicus	Och		–		–		–		–		122.0		–
Saccharina sp.	Och		116.0		–		–		–		–		–
Sargassum miyabei	Och		80.0		–		2.0		–		–		–
Cladophora speciosa	Ch		–		–		–		–		–		22.0
Corallina pilulifera	Rh		14.4		–		–		–		–		–
Total biomass of plants			942.4		815.0		467.0		1367.0		412.0		742.0
ANIMALS													
Chthamalus dalli	Ci	–	–	–	–	–	–	–	–	1000	10.0	300	35.0
Lottia persona	Ga	–	–	600	32.0	–	–	–	–	–	–	–	–
Falsicingula kurilensis	Ga	520	2.8	2900	5.0	6700	30.0	–	–	–	–	–	–
Nucella heyseana	Ga	–	–	–	–	300	24.0	–	–	–	–	–	–
Telmessus cheiragonus	De	40	2.0	–	–	100	7.0	400	20.0	–	–	–	–
Nassarius fraterculus	Ga	–	–	–	–	400	18.0	–	–	–	–	–	–
Littorina sitkana	Ga	–	–	–	–	300	10.0	–	–	–	–	–	–
Ampithoe kussakini	Am	80	0.4	1100	6.0	200	3.0	–	–	–	–	–	–
Ampithoe tarasovi	Am	80	2.4	–	–	–	–	–	–	–	–	–	–
Corophium sp.	Am	–	–	–	–	–	–	–	–	–	–	900	2.0
Lottia pelta	Ga	–	–	–	–	–	–	–	–	100	2.0	–	–
Spionidae	Po	–	–	–	–	–	–	100	1.0	–	–	–	–
Turtonia minuta	Bi	80	0.4	300	1.0	–	–	–	–	–	–	100	0.5
Cliamenella fraudatrix	Is	–	–	–	–	–	–	–	–	200	1.0	–	–
Amphipoda	Am	–	–	–	–	–	–	–	–	400	0.6	–	–
Pantopoda	Pa	–	–	–	–	–	–	100	0.5	–	–	–	–
Idotea ochotensis	Is	–	–	–	–	–	–	100	0.5	–	–	–	–
Ampithoe sp.	Am	80	0.3	–	–	–	–	–	–	–	–	–	–
Total biomass of animals			8.3		44.0		92.0		22.0		13.6		37.5
Total biomass			950.7		859.0		559.0		1389.0		425.6		779.5

Table 9. Density (N, individuals m^{-2}) and biomass (B, g wet wt m^{-2}) of macrobenthos on the boundary between the middle and lower intertidal subzones, on the blocky-bouldery substratum. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Yuzhno-Kurilskaya Bay (location 19)			
		Sabellidae settlings		*Abietinaria filicula* settlings	
		N	B	N	B
PLANTS					
Saccharina sp.	Och		–		350.0
Total biomass of plants			–		350.0
ANIMALS					
Sabellidae	Po	9350	20700.0	–	–
Naineris jacutica	Po	8900	1395.0	–	–
Abietinaria filicula	Hy		–		1169.0
Lottia pelta	Ga	–	–	200	363.0
Ascidiacea	As		–		163.0
Oulactis orientalis	Ac	100	153.0	–	–
Cryptosula zavjalovensis	Bry		–		149.0
Celleporella hyalina	Bry		–		145.0
Cnidopus japonicus	Ac	–	–	200	88.5
Nereis pelagica	Po	200	17.8	500	8.8
Nereis zonata	Po	400	16.2	–	–
Eteone longa	Po	100	3.2	100	1.0
Syllis hyalina	Po	100	1.4	100	0.4
Apohyale bassargini	Am	–	–	200	1.2
Vilasina pillula	Bi	–	–	100	1.0
Abietinaria thuiarioides	Hy		–		0.7
Halecium lucium	Hy		–		0.6
Pantopoda	Pa	–	–	300	0.5
Eudendrium vaginatum	Hy		–		0.2
Total biomass of animals			22286.6		2091.9
Total biomass			22286.6		2441.9

Table 10. Density (N, individuals m^{-2}) and biomass (B, g wet wt m^{-2}) of macrobenthos on the boundary between the middle and lower intertidal subzones, on the sandy substratum. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Pervukhina Bay (location 1)		Cape Kruglyy (location 2)		Yuzhno-Kurilskaya Bay (location 19)	
		Phyllospadix iwatensis belt		*Phyllospadix iwatensis* patches		*Phyllospadix iwatensis* belt	
		N	B	N	B	N	B
PLANTS							
Phyllospadix iwatensis	Tra		10928.0		620.0		5528.0
Corallina pilulifera	Rh		+		6.0		–
Total biomass of plants			10928.0		626.0		5528.0
ANIMALS							
Oulactis orientalis	Ac	–	–	+	+	80	604.0
Naineris jacutica	Po	80	24.0	480	21.4	5080	404.0
Chone teres	Po	11840	390.0	2560	90.0	6240	364.0
Nucella heyseana	Ga	40	0.8	+	+	80	130.0
Telmessus cheiragonus	De	+	+	–	–	40	80.0
Eudistylia suavis	Po	–	–	–	–	40	48.0
Nereis vexillosa	Po	40	31.4	80	25.5	120	35.0
Pseudopotamilla occelata	Po	–	–	–	–	40	34.8
Littorina sitkana	Ga	–	–	–	–	120	16.0
Cirratulidae	Po	+	+	240	11.2	–	–
Idotea ochotensis	Is	40	0.4	+	+	80	10.0
Nassarius fraterculus	Ga	–	–	40	8.0	–	–
Protothaca euglypta	Bi	40	8.0	–	–	–	–
Glycinde armigera	Po	40	6.4	80	5.6	–	–
Nereis zonata	Po	80	5.0	80	1.4	–	–
Eudendrium vaginatum	Hy		–		–		4.4
Eteone longa	Po	–	–	–	–	120	4.0
Polynoidae	Po	+	+	–	–	40	3.6
Maldanidae	Po	–	–	200	2.4	–	–
Capitella capitata	Po	40	0.4	120	2.0	–	–
Ampithoe kussakini	Am	+	+	+	+	40	2.0
Typosyllis adamanteus	Po	–	–	40	1.2	–	–
Lumbrineris japonica	Po	–	–	40	1.0	–	–

Taxa	Taxonomic group	Pervukhina Bay (location 1)		Cape Kruglyy (location 2)		Yuzhno-Kurilskaya Bay (location 19)	
		Phyllospadix iwatensis belt		*Phyllospadix iwatensis* patches		*Phyllospadix iwatensis* belt	
		N	B	N	B	N	B
Typosyllis sp.	Po	–	–	–	–	80	1.0
Mysella kurilensis litoralis	Bi	120	1.0	–	–	–	–
Epheria turrita	Ga	40	0.8	–	–	–	–
Pontogeneia sp.	Am	160	0.8	–	–	–	–
Falsicingula kurilensis	Ga	80	0.4	–	–	40	0.4
Haloconcha minor	Ga	40	0.4	–	–	–	–
Turtonia minuta	Bi	80	0.4	–	–	–	–
Pontogeneia kondakovi	Am	80	0.3	–	–	–	–
Anonyx sp.	Am	40	0.3	–	–	–	–
Gnorimosphaeroma noblei	Is	80	0.1	–	–	40	0.3
Parallorchestes ochotensis	Am	40	0.2	+	+	–	–
Holotelson tuberculatus	Is	40	0.2	+	+	–	–
Syllis hyalina	Po	–	–	–	–	40	0.2
Cleantiella isopus	Is	40	0.0	–	–	–	–
Total biomass of animals			471.3		169.7		1741.7
Total biomass			11399.3		795.7		7269.7

Table 11. Density (N, individuals m^{-2}) and biomass (B, g wet wt m^{-2}) of macrobenthos in the lower intertidal subzone on the rocky, rocky-bouldery, and blocky-bouldery substrata. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Pervukhina Bay (location 1)						Cape Kruglyy (location 2)				Yuzhno-Kurilskaya Bay (location 19)		Cape Rogacheva (location 23)	
		Sargassum miyabei belt		*Scytosiphon lomentaria* belt		*Saccharina* sp. belt		*Sargassum miyabei* belt		*Sargassum thunbergii* belt		*Saccharina* sp. belt		*Alaria ochotensis* belt	
		N	B	N	B	N	B	N	B	N	B	N	B	N	B
PLANTS															
Saccharina sp.	Och		–		–		10280.0		–		–		106880.0		+
Alaria ochotensis	Och		–		–		–		–		–		–		8850.0
Sargassum thunbergii	Och		36.0		–		–		–		6008.0		–		–
Scytosiphon lomentaria	Och		–		4440.0		–		–		–		–		–
Sargassum miyabei	Och		4280.0		88.0		–		1992.0		–		–		–
Neorhodomela aculeata	Rh		200.0		–		–		644.0		–		–		–
Pterosiphonia bipinnata	Rh		–		–		–		–		–		–		596.0
Mastocarpus pacificus	Rh		–		–		–		273.2		–		–		–
Mazzaella parksii	Rh		–		–		–		–		–		–		164.0
Corallina pilulifera	Rh		–		1.6		–		28.0		73.6		–		46.0
Ulva lactuca	Ch		–		24.8		–		–		–		–		–
Analipus japonicus	Och		–		–		–		–		–		–		13.0
Costaria costata	Och		–		8.8		–		–		–		–		–
Tichocarpus crinitus	Rh		–		6.0		–		–		–		–		–
Chordaria flagelliformis	Och		–		4.0		–		–		–		–		–
Laurencia nipponica	Rh		–		4.0		–		–		–		–		–
Porphyra sp.	Rh		–		2.0		–		–		–		–		–
Total biomass of plants			4516.0		4579.2		10280.0		2937.2		6081.6		106880.0		9669.0
ANIMALS															
Semibalanus cariosus	Ci	–	–	–	–	–	–	–	–	–	–	–	–	500	827.0
Chthamalus dalli	Ci	–	–	–	–	–	–	–	–	–	–	–	–	1740	420.0
Nucella freycinetii	Ga	–	–	–	–	–	–	–	–	–	–	–	–	80	67.8
Falsicingula kurilensis	Ga	6760	22.0	40	0.4	600	3.2	22600	57.9	16200	63.2	–	–	–	–
Nassarius fraterculus	Ga	–	–	–	–	–	–	640	58.0	40	4.8	–	–	–	–
Eudendrium vaginatum	Hy		–		–		–		–		–		56.0		0.4
Lottia pelta	Ga	–	–	–	–	–	–	–	–	–	–	–	–	200	50.0
Mytilus trossulus kussakini	Bi	–	–	–	–	–	–	–	–	–	–	–	–	60	49.0
Littorina sitkana	Ga	–	–	–	–	–	–	600	30.0	40	2.0	–	–	2380	43.0
Homalopoma sangarense	Ga	+	+	+	+	–	–	80	30.0	–	–	–	–	–	–
Parallorchestes ochotensis	Am	40	0.2	–	–	–	–	–	–	–	–	140	1.8	560	28.0
Nucella heyseana	Ga	–	–	–	–	–	–	–	–	120	24.0	–	–	–	–
Apohyale bassargini	Am	200	0.6	–	–	40	0.2	200	0.8	24160	19.4	120	0.6	80	0.2
Nereis pelagica	Po	–	–	–	–	–	–	–	–	–	–	280	6.5	720	15.0
Idotea ochotensis	Is	–	–	–	–	–	–	40	14.0	–	–	–	–	–	–

Taxa	Taxonomic group	Pervukhina Bay (location 1)						Cape Kruglyy (location 2)				Yuzhno-Kurilskaya Bay (location 19)		Cape Rogacheva (location 23)	
		Sargassum miyabei belt		*Scytosiphon lomentaria* belt		*Saccharina* sp. belt		*Sargassum miyabei* belt		*Sargassum thunbergii* belt		*Saccharina* sp. belt		*Alaria ochotensis* belt	
		N	B	N	B	N	B	N	B	N	B	N	B	N	B
Hiatella arctica	Bi	–	–	–	–	–	–	–	–	–	–	–	–	380	10.0
Lottia persona	Ga	–	–	–	–	–	–	–	–	80	9.2	–	–	–	–
Pusilina plicosa	Ga	80	0.3	–	–	–	–	1440	9.1	–	–	–	–	–	–
Ampithoe kussakini	Am	120	1.0	–	–	40	0.2	440	7.4	480	3.5	–	–	–	–
Nemertea	Ne	–	–	–	–	–	–	–	–	–	–	–	–	60	4.0
Ampithoe sp.	Am	120	0.8	360	3.6	–	–	–	–	–	–	–	–	–	–
Telmessus cheiragonus	De	40	3.2	–	–	–	–	40	2.0	–	–	–	–	–	–
Polynoidae	Po	40	3.0	–	–	–	–	–	–	–	–	–	–	–	–
Ischyrocerus sp.	Am	–	–	–	–	–	–	–	–	2960	2.7	–	–	–	–
Nereis sp.	Po	40	2.0	–	–	–	–	–	–	–	–	–	–	–	–
Harmothoe imbricata	Po	–	–	–	–	–	–	40	2.0	–	–	–	–	–	–
Actiniidae juv.	Ac	40	2.0	–	–	–	–	–	–	–	–	–	–	–	–
Cliamenella fraudatrix	Is	–	–	–	–	–	–	–	–	120	0.2	–	–	640	1.6
Caprella bispinosa	Am	–	–	520	1.3	–	–	120	0.5	–	–	–	–	–	–
Ampithoe lacertosa	Am	40	1.2	–	–	–	–	–	–	–	–	–	–	–	–
Ampithoe volki	Am	–	–	–	–	360	1.0	–	–	–	–	–	–	–	–
Naineris jacutica	Po	–	–	–	–	–	–	–	–	–	–	20	0.8	–	–
Turtonia minuta	Bi	160	0.8	–	–	–	–	–	–	40	0.2	–	–	–	–
Metopa sp.	Am	–	–	–	–	–	–	–	–	440	0.8	–	–	–	–
Caprella cristibrachium	Am	–	–	–	–	–	–	–	–	840	0.7	–	–	–	–
Chone sp.	Po	–	–	–	–	–	–	–	–	–	–	80	0.7	–	–
Holotelson tuberculatus	Is	–	–	–	–	–	–	360	0.5	–	–	–	–	–	–
Protothaca euglypta	Bi	40	0.5	–	–	–	–	–	–	–	–	–	–	–	–
Typosyllis sp.	Po	–	–	–	–	120	1.2	40	0.4	–	–	80	0.1	–	–
Pagurus sp. juv.	De	–	–	–	–	–	–	100	0.4	–	–	–	–	–	–
Jassa marmorata	Am	–	–	–	–	–	–	–	–	–	–	–	–	60	0.4
Pontogeneia sp.	Am	–	–	–	–	40	0.2	–	–	120	0.3	–	–	–	–
Caprella sp.	Am	80	0.1	–	–	–	–	80	0.2	–	–	–	–	–	–
Musculista senhousia	Bi	–	–	–	–	–	–	–	–	–	–	–	–	620	0.2
Campanularia volubilis	Hy		–		–		–		–		–		0.2		–
Capitella capitata	Po	–	–	–	–	–	–	–	–	–	–	40	0.2	–	–
Pleusymtes sp.	Am	–	–	–	–	–	–	80	0.2	–	–	–	–	–	–
Ischyrocerus cristatus	Am	–	–	–	–	–	–	40	0.1	40	0.2	–	–	–	–
Pantopoda	Pa	40	0.0	–	–	–	–	–	–	–	–	20	0.1	–	–
Ischyrocerus anguipes	Am	–	–	–	–	–	–	40	0.1	–	–	–	–	–	–
Corophium sp.	Am	–	–	–	–	–	–	–	–	–	–	20	0.0	–	–
Total biomass of animals			37.7		5.3		6.0		213.6		131.2		67.0		1516.0
Total biomass			4553.7		4584.5		10286.0		3150.8		6212.8		106947.0		11185.0

Table 12. Density (N, individuals m^{-2}) and biomass (B, g wet wt m^{-2}) of macrobenthos in the middle and lower intertidal subzones on the sandy-silted-gravelly substratum. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Izmeny Bay (location 10)					
		Batillaria cumingii belt		*Zostera japonica* belt		*Zostera marina* belt	
		N	B	N	B	N	B
PLANTS							
Zostera japonica	Tra		–		1427.7		–
Zostera marina	Tra		–		–		1265.6
Chordaria sp.	Och		–		60.0		–
Total biomass of plants			–		1487.7		1265.6
ANIMALS							
Batillaria cumingii	Ga	1600	445.6	140	67.6	200	77.6
Ruditapes philippinarum	Bi	80	15.6	30	342.3	80	1027.6
Nassarius fraterculus	Ga	120	22.8	80	11.3	–	–
Abarenicola pacifica	Po	80	15.6	100	12.8	40	0.2
Nereis vexillosa	Po	–	–	140	14.1	120	12.8
Nassarius multigranosus	Ga	–	–	–	–	120	9.6
Macoma incongrua	Bi	–	–	30	2.5	40	7.6
Alitta brandti	Po	–	–	–	–	40	6.0
Naineris jacutica	Po	–	–	–	–	80	4.6
Glycinde armigera	Po	–	–	–	–	40	4.2
Hediste japonica	Po	40	4.0	–	–	–	–
Chone sp.	Po	–	–	–	–	840	3.6
Nereis pelagica	Po	–	–	–	–	120	2.8
Gnorimosphaeroma noblei	Is	–	–	240	1.3	–	–
Polychaeta	Po	–	–	30	0.9	–	–
Lepidepecreum sp.	Am	–	–	150	0.7	–	–
Turtonia minuta	Bi	–	–	160	0.4	–	–
Cerithiopsis stejnegeri	Ga	–	–	–	–	80	0.4
Pusilina plicosa	Ga	–	–	–	–	200	0.2
Nereis sp.	Po	–	–	150	0.1		
Ampithoe sp.	Am	–	–	10	0.1	–	–
Gastropoda juv.	Ga	–	–	30	0.1	–	–
Dogielinotus moskvitini	Am	–	–	10	0.1	–	–
Falsicingula kurilensis	Ga	–	–	30	0.1	–	–
Lirularia iridescens	Ga	–	–	–	–	840	0.0
Allorchestes malleolus	Am	–	–	10	0.0	–	–
Leptostraca	Le	–	–	10	0.0	–	–
Cumacea	Cu	–	–	10	0.0	–	–
Total biomass of animals			503.6		454.4		1157.2
Total biomass			503.6		1942.1		2422.8

Table 13. Density (N, individuals m^{-2}) and biomass (B, g wet wt m^{-2}) of macrobenthos on the boundary of transition of the walls of the tide pool into the top part of reef. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Cape Rogacheva (location 23)					
		Littorina sitkana belt		*Chthamalus dalli* + *Littorina sitkana* patches		*Gloiopeltis furcata* patches	
		N	B	N	B	N	B
PLANTS							
Gloiopeltis furcata	Rh		–		–		500.0
Total biomass of plants							500.0
ANIMALS							
Littorina sitkana	Ga	5800	290.0	6100	50.0	8200	155.0
Chthamalus dalli	Ci	–	–	5000	70.0	600	5.0
Apohyale bassargini	Am	–	–	–	–	1600	5.0
Cliamenella fraudatrix	Is	–	–	–	–	600	2.0
Total biomass of animals			290.0		120.0		167.0
Total biomass			290.0		120.0		667.0

Table 14. Density (N, individuals m^{-2}) and biomass (B, g wet wt m^{-2}) of macrobenthos on the walls of the tide pool. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Cape Rogacheva (location 23)					
		Silvetia babingtonii belt		*Fucus evanescens* patches		*Analipus japonicus* patches	
		N	B	N	B	N	B
PLANTS							
Silvetia babingtonii	Och		18440.0		–		+
Fucus evanescens	Och		10.0		8208.0		20.0
Analipus japonicus	Och		–		–		970.0
Corallina pilulifera	Rh		–		–		90.0
Total biomass of plants			18450.0		8208.0		1080.0
ANIMALS							
Littorina sitkana	Ga	18400	360.0	4720	128.0	200	5.0
Nucella freycinetii	Ga	–	–	80	36.0	–	–
Lottia persona	Ga	160	20.4	+	+	–	–
Chthamalus dalli	Ci	240	13.6	160	6.0	–	–
Apohyale bassargini	Am	920	12.0	1400	6.0	100	0.1
Cliamenella fraudatrix	Is	–	–	–	–	700	1.2
Nereis sp.	Po	–	–	–	–	200	1.0
Pontogeneia sp.	Am	–	–	–	–	100	0.7
Abietinaria filicula	Hy		0.2		–		–
Gnorimosphaeroma noblei	Is	40	0.0	+	+	–	–
Total biomass of animals			406.2		176.0		8.0
Total biomass			18856.2		8384.0		1088.0

Table 15. Density (N, individuals m^{-2}) and biomass (B, g wet wt m^{-2}) of macrobenthos on the bottom of the tide pool in the plant communities with projective cover up to 90%. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Cape Rogacheva (location 23)			
		Corallina pilulifera		*Phyllospadix iwatensis*	
		N	B	N	B
PLANTS					
Phyllospadix iwatensis	Tra		–		8320.0
Corallina pilulifera	Rh		1282.0		292.0
Cladophora opaca	Ch		10.0		–
Neorhodomela munita	Rh		1.0		–
Chaetomorpha moniligera	Ch		0.5		–
Total biomass of plants			1293.5		8612.0
ANIMALS					
Protothaca euglypta	Bi	–	–	760	48.0
Falsicingula kurilensis	Ga	9700	39.0	1000	2.0
Naineris jacutica	Po	–	–	1160	33.3
Littorina sitkana	Ga	6400	20.0	1640	20.0
Nereis pelagica	Po	–	–	560	18.9
Phascolosoma (*Physcosoma*) *agassizii*	Si	–	–	40	16.0
Polychaeta	Po	200	5.0	–	–
Hiatella arctica	Bi	–	–	80	4.8
Lumbrineris japonica	Po	–	–	80	1.5
Nucella heyseana	Ga	100	1.0	+	+
Cliamenella fraudatrix	Is	400	1.0	–	–
Pantopoda	Pa	–	–	80	0.8
Bryozoa	Bry		–		0.8
Sertularia similis	Hy		–		0.4
Eudendrium vaginatum	Hy		–		0.4
Mysella kurilensis litoralis	Bi	–	–	40	0.4
Abietinaria filicula	Hy		–		0.2
Syllis hyalina	Po	–	–	40	0.2
Total biomass of animals			66.0		147.7
Total biomass			1359.5		8759.7

Table 16. Density (N, individuals m^{-2}) and biomass (B, g wet wt m^{-2}) of macrobenthos on the bottom of the tide pool in the plant communities with projective cover up to 10%. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Cape Rogacheva (location 23)											
		Neodilsea yendoana patches		*Pterosiphonia bipinnata* patches		*Neorhodomela aculeata* + *Neorhodomela oregona* patches		*Mazzaella parksii* patches		*Chaetomorpha linum* patches		*Chaetomorpha melagonium* patches	
		N	B	N	B	N	B	N	B	N	B	N	B
PLANTS													
Mazzaella parksii	Rh		–		–		–		7950.0		–		–
Pterosiphonia bipinnata	Rh		–		6950.0		–		–		–		–
Neodilsea yendoana	Rh		3950.0		–		–		–		–		–
Chaetomorpha linum	Ch		–		–		12.5		–		2620.0		–
Neorhodomela aculeata	Rh		–		–		1832.5		–		–		177.0
Neorhodomela oregona	Rh		–		–		975.0		–		–		–
Chaetomorpha melagonium	Ch		–		–		–		–		+		320.0
Corallina pilulifera	Rh		200.0		–		81.3		1110.0		10.0		–
Clathromorphum sp.	Rh		–		–		–		17.0		–		–
Phyllospadix iwatensis	Tra		–		–		6.3		–		–		–
Total biomass of plants			4150.0		6950.0		2907.6		9077.0		2630.0		497.0
ANIMALS													
Hiatella arctica	Bi	–	–	–	–	25	0.5	1800	202.0	–	–	–	–
Littorina sitkana	Ga	200	2.0	200	5.0	6575	113.5	7100	98.0	7300	30.0	1500	4.1
Chthamalus dalli	Ci	–	–	500	100.0	–	–	–	–	–	–	–	–
Nereis pelagica	Po	–	–	1700	50.0	–	–	–	–	–	–	–	–
Apohyale bassargini	Am	100	9.0	4000	16.6	225	0.6	200	29.0	500	2.0	100	17.4
Idotea ochotensis	Is	80	25.0	–	–	25	0.2	–	–	–	–	–	–
Pontogeneia sp.	Am	–	–	1400	3.0	6175	20.2	–	–	–	–	–	–
Cliamenella fraudatrix	Is	100	0.5	9400	17.0	650	1.3	900	2.0	100	0.7	–	–
Nucella heyseana	Ga	–	–	–	–	50	15.0	–	–	–	–	–	–
Falsicingula kurilensis	Ga	–	–	300	0.6	375	1.8	3700	6.5	700	5.0	900	1.0
Ascidiacea	As		5.0		–		–		–		–		–
Parallorchestes ochotensis	Am	–	–	–	–	–	–	100	4.7	–	–	–	–
Nereis sp.	Po	–	–	–	–	–	–	300	4.0	–	–	–	–
Nassarius fraterculus	Ga	–	–	–	–	50	2.5	–	–	–	–	–	–
Panomya sp.	Bi	–	–	200	2.0	–	–	–	–	–	–	–	–
Lottia persona	Ga	–	–	–	–	50	1.0	100	1.0	–	–	–	–
Abietinaria filicula	Hy		1.0		–		–		+		–		–
Allorchestes malleolus	Am	100	1.0	–	–	–	–	–	–	–	–	–	–
Gnorimosphaeroma noblei	Is	–	–	–	–	–	–	–	–	100	0.6	–	–
Mysella kurilensis litoralis	Bi	–	–	–	–	–	–	100	0.5	–	–	–	–
Pantopoda	Pa	–	–	–	–	–	–	100	0.5	–	–	–	–
Ischyrocerus sp.	Am	100	0.4	–	–	25	0.0	–	–	–	–	–	–
Sertularella spinosa	Hy		–		–		–		0.2		–		–
Total biomass of animals			43.9		194.2		156.6		348.4		39.3		22.5
Total biomass			4193.9		7144.2		3064.2		9425.4		2668.3		519.5

Plate 1

Plate 1. The general view of the rocky-bouldery intertidal zone on reef in the Pervukhina Bay.

Plate 2

Plate 2. Communities of the upper intertidal subzone. A – the *Littorina sitkana* community; B – the *Chthamalus dalli* community; C – the *Gloiopeltis furcata* community.

Plate 3

Plate 3. The *Fucus evanescens* community in the middle intertidal subzone. The upper photo – water level is 0.3 m.

Plate 4

Plate 4. The brown algae communities in the middle intertidal subzone. A – the *Fucus evanescens* community and the *Silvetia babingtonii* patches; B – the *Analipus japonicus* community.

Plate 5

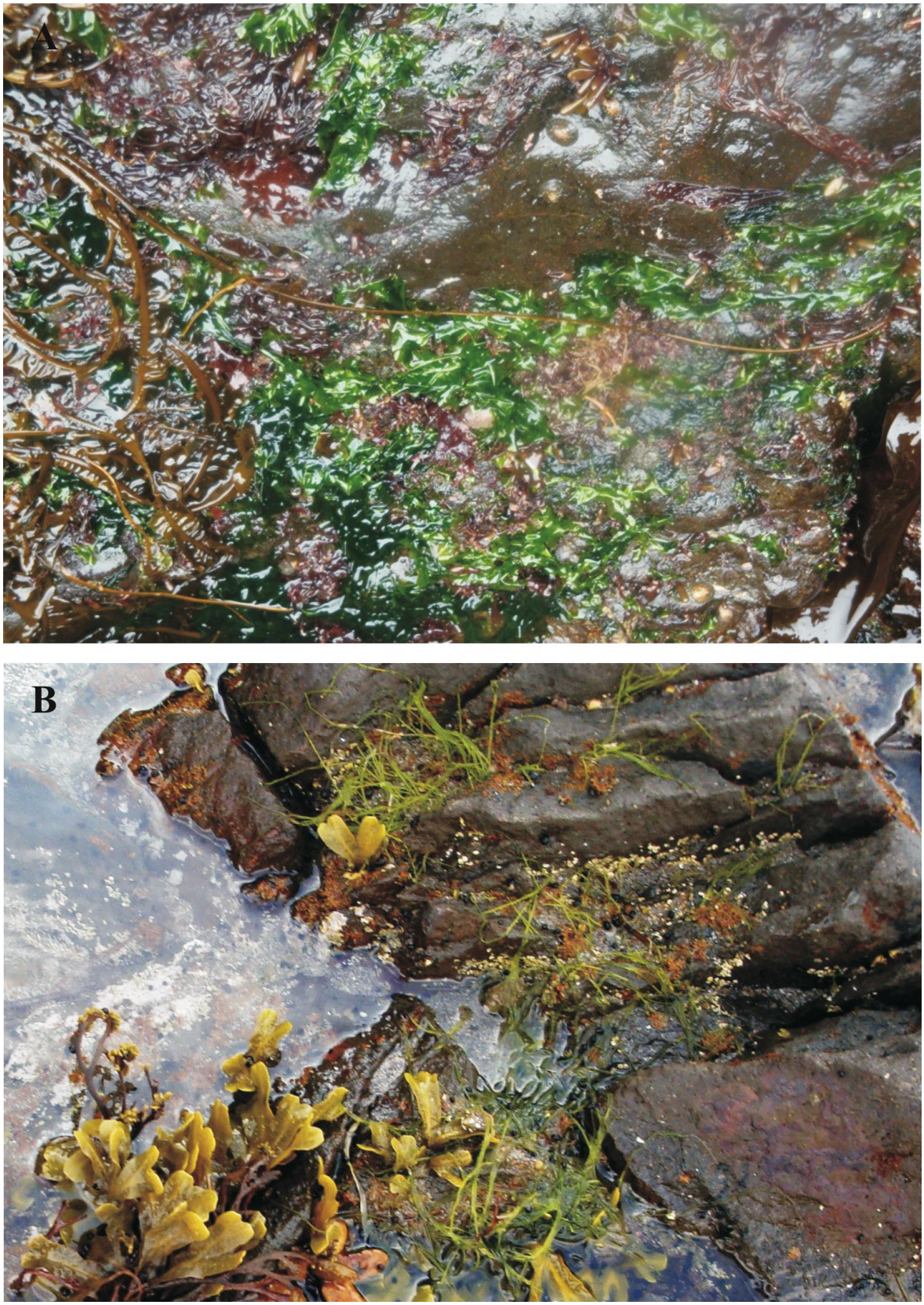

Plate 5. The green algae communities in the middle intertidal subzone. A – the *Ulva lactuca* community; B – the *Chaetomorpha moniligera* community.

Plate 6

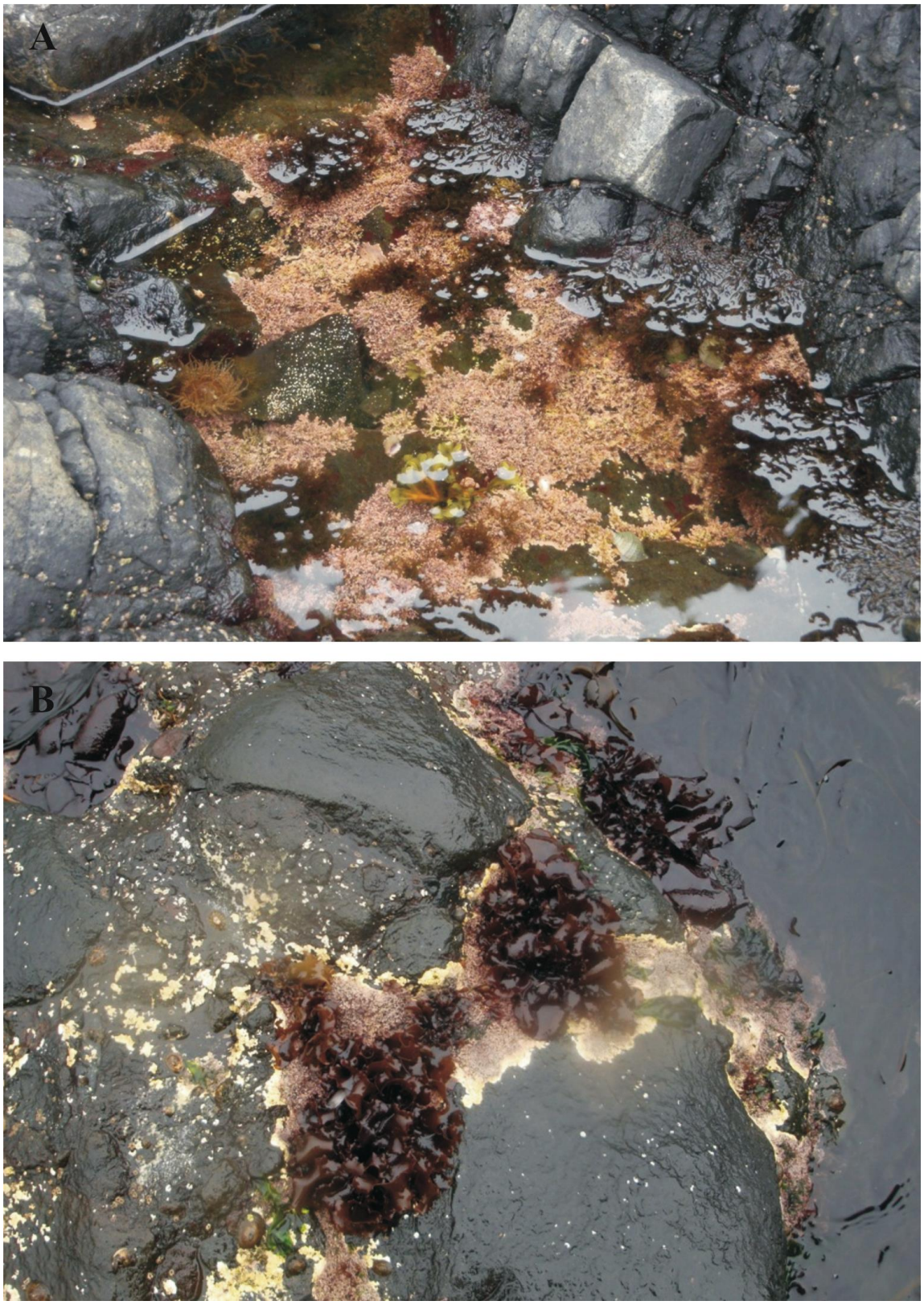

Plate 6. The red algae communities in the middle intertidal subzone. A – the *Corallina pilulifera* community; B – the *Mazzaella parksii* community.

Plate 7

Plate 7. Communities in the lower part of the middle intertidal subzone and lower intertidal subzone (water level is 0.3–0.4 m). A – the *Phyllospadix iwatensis* community; B – the *Sargassum miyabei* community.

Plate 8

Plate 8. Laminarian communities in the lower intertidal subzone. The upper photo – water level is 0.4 m.

Plate 9

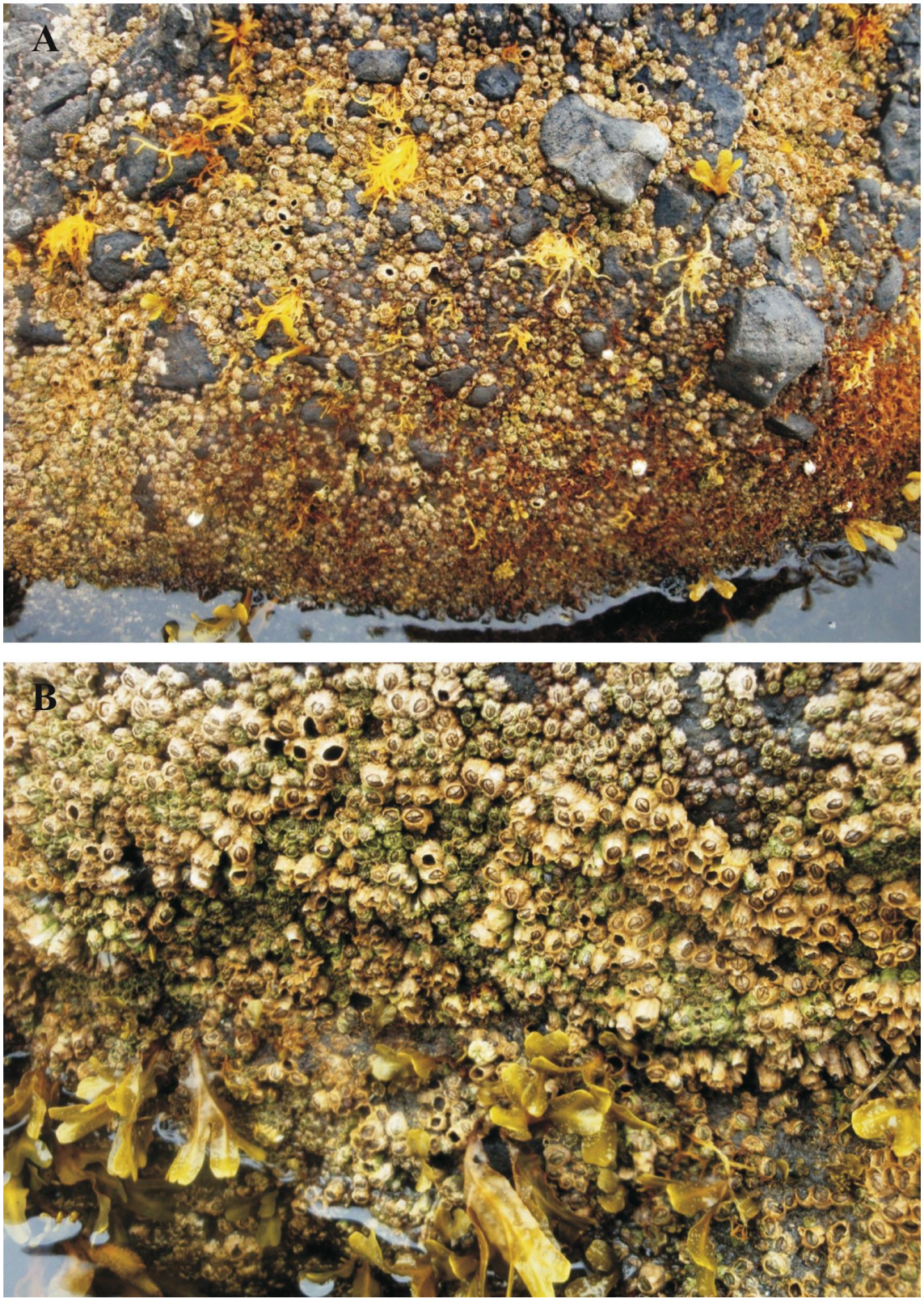

Plate 9.
Vertical distribution of macrobenthos on the boundary between the upper and middle intertidal subzones. A – belt of *Chthamalus dalli* with patches of *Gloiopeltis furcata*, and crustose bases of *Analipus japonicus* are below *Ch. dalli*; B – belts of *Chthamalus dalli* and *Fucus evanescens*.

Plate 10

Plate 10. Vertical distribution of macrobenthos in the middle intertidal subzone. A – patches of the brown alga *Analipus japonicus*, the red alga *Mazzaella parksii*, and barnacle *Chthamalus dalli*; B – belt of *Fucus evanescens,* and over – settlings of *Chthamalus dalli*.

Plate 11

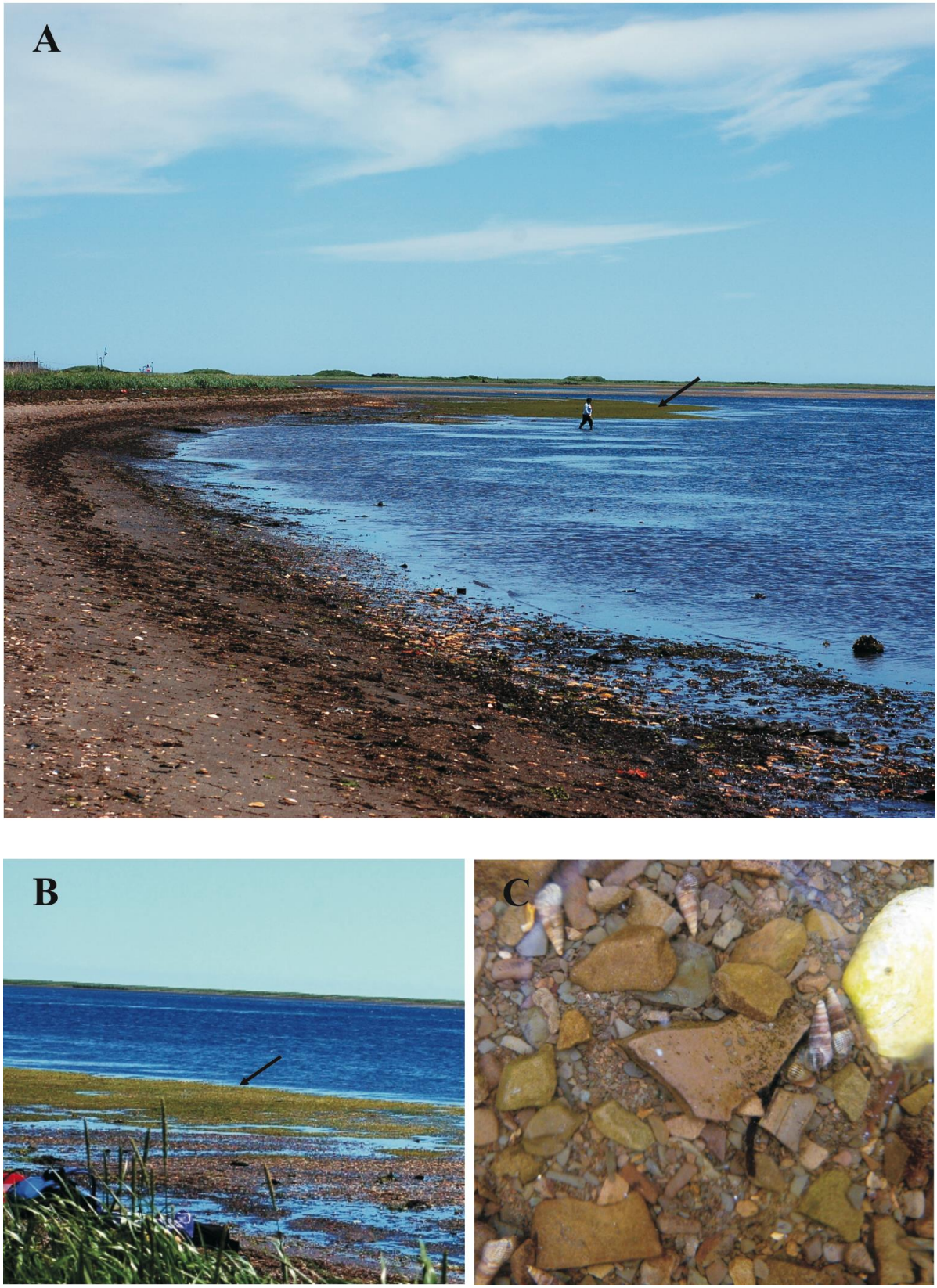

Plate 11. Intertidal zone in the Izmeny Bay. A – the *Zostera* field (show by arrow); B – the *Zostera marina* belt-forming community (show by arrow); C – the *Batillaria cumingii* community.

Plate 12

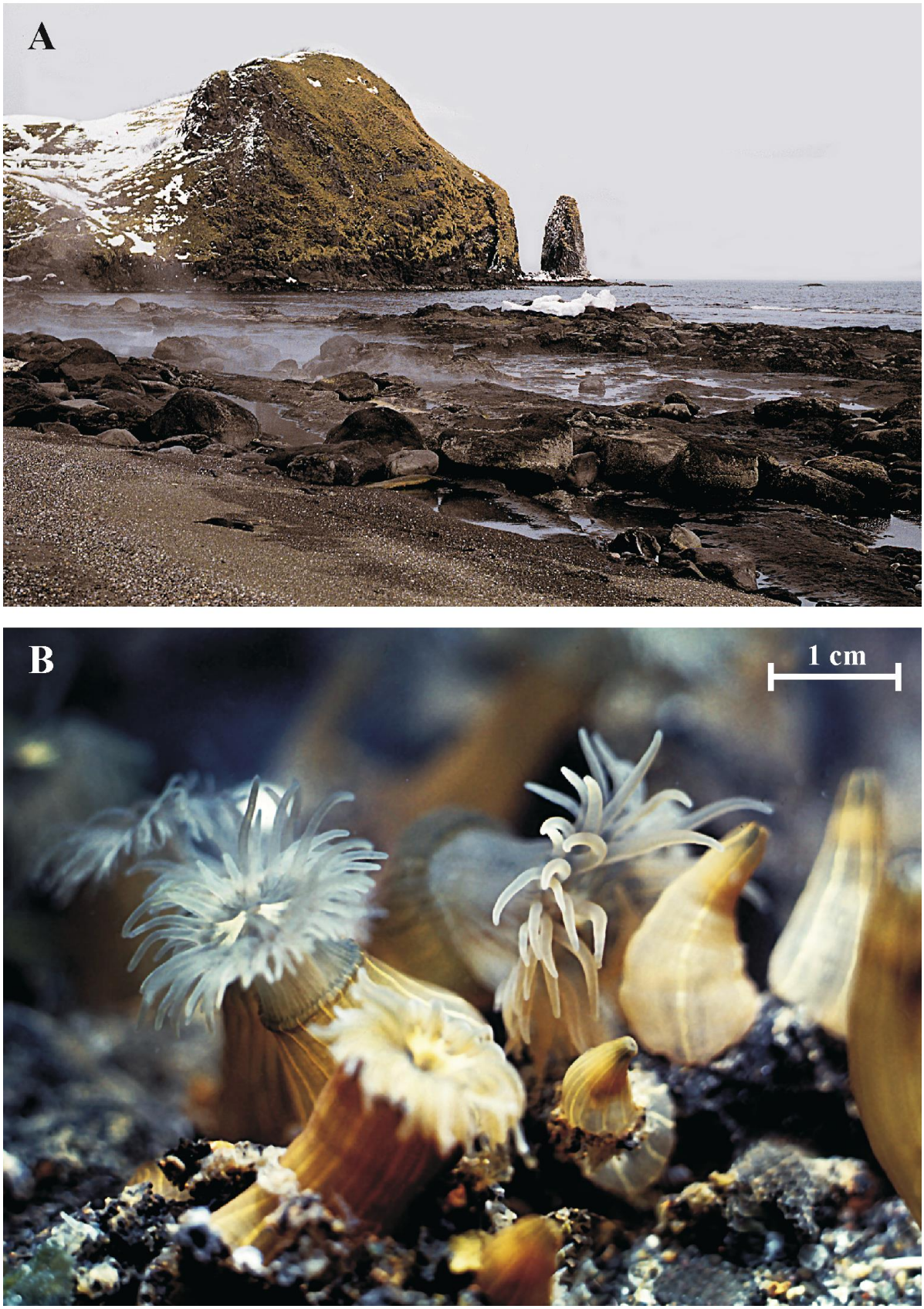

Plate 12. The general view of the intertidal zone of the Goryachiy Plyazh (A) and sea anemone *Diadumene lineata* (B).

Plate 13

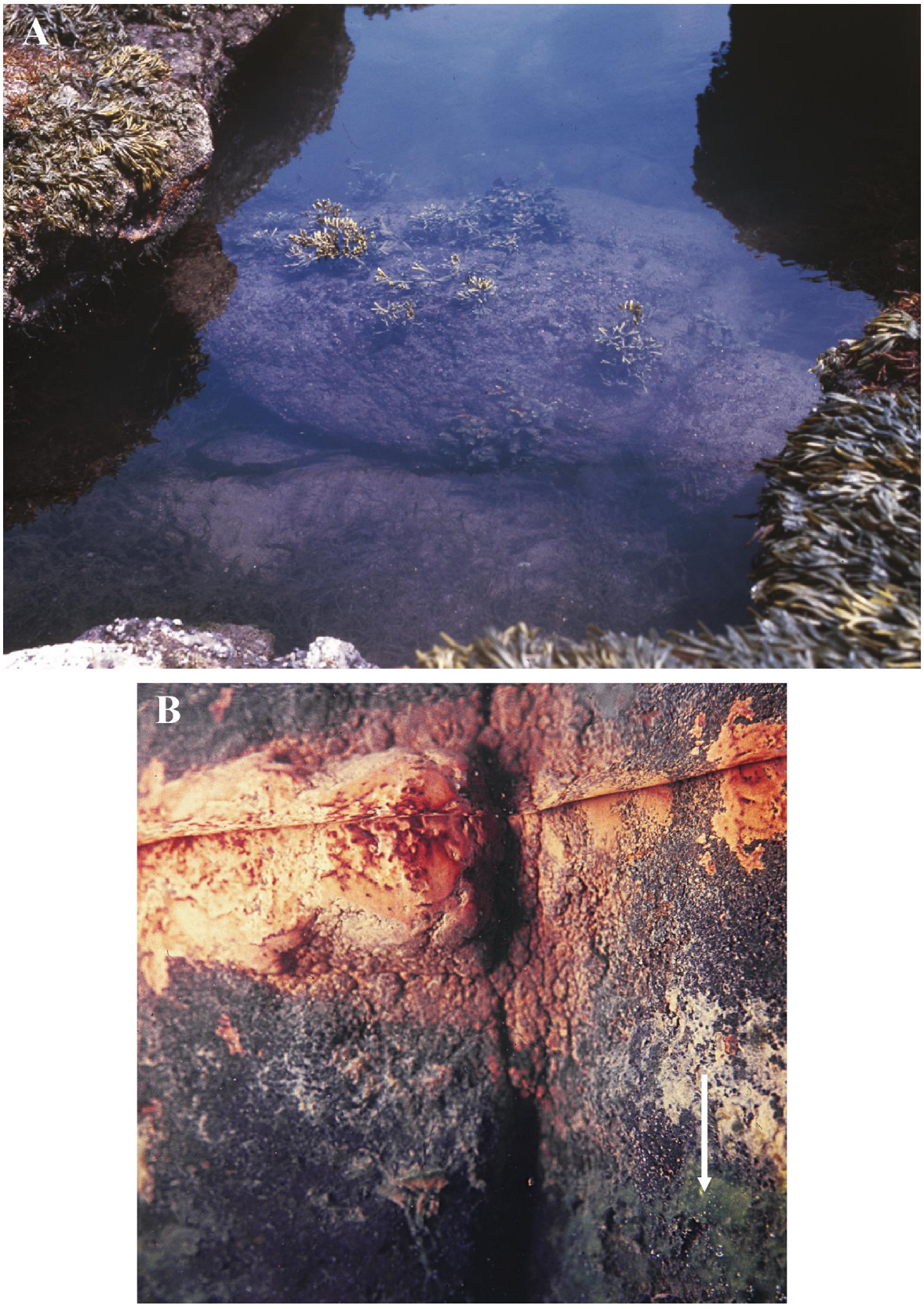

Plate 13. The tide pools on the Goryachiy Plyazh. A – the tide pool with "cold" volcanic H_2S seeps; B – the tide pool with "hot" volcanic H_2S seeps (the algal-bacterial mats is indicated by arrow).

Plate 14

Plate 14. Samplings in the intertidal zone. A – the quantitative samplings in the upper intertidal subzone; B – the quantitative samplings in the middle intertidal subzone; C – the qualitative samplings in the lower intertidal subzone.

Appendix

The list of the macrobenthic plants and animals of the intertidal zone of Kunashir Island

The larvae of Insecta have not been identified. Some groups (Nemertea, Polychaeta, Amphipoda, Isopoda, Cumacea, Pantopoda, Leptostraca, Bryozoa, Ascidiacea, juveniles of gastropods and sea anemones) are partly identified.

The Latin names of species mentioned in previous publications (Kussakin, 1956, 1957, 1975; Zinova and Perestenko, 1974; Kussakin and Tarakanova, 1977; Kostina, 1991) are enclosed in square brackets if these names are true synonyms (=), and it is not determined whether the species of true synonyms or it is incorrectly applied name ("as").

Abbreviations: E – eastern coast, W – western coast, and S – southern coast of Kunashir Island; BG – biogeographical group. In the column "biogeographical group", the following abbreviations of species are given: ab. – amphi-boreal; ap. – amphi-Pacific; as. – near-Asiatic; at. – anti-tropical; b.-a. – boreal-Arctic; hb. – high-boreal; lb. – low-boreal; n.-tr.-b.(lb. or st.) – notal-tropical-boreal (low-boreal or subtropical); p.– Pacific; p.-o. – panoceanic; st.-b.(lb.) – subtropical-boreal (low-boreal); st.(tr.)-b.-a. – subtropical (tropical)-boreal-Arctic; tr.-st.(lb. or b.) – tropical-subtropical (low-boreal or boreal); wb. – widespread boreal; mz. – multizonal.

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
PLANTS							
Regnum CHROMISTA							
Phylum Ochrophyta							
Classis Phaeophyceae							
Ordo Desmarestiales							
Familia Desmarestiaceae							
Desmarestia aculeata (Linnaeus) J.V. Lamouroux	+						b.-a.
Desmarestia viridis (O.F. Müller) J.V. Lamouroux					+		?at.
Ordo Ectocarpales							
Familia Acinetosporaceae							
Pylaiella littoralis (Linnaeus) Kjellman, *nomen conservandum*	+						mz.
Familia Chordariaceae							
Acrothrix pacifica Okamura et Yamada	+				+		as. st.-lb.
Chordaria chordaeformis (Kjellman) H. Kawai et S.-H. Kim [=*Chordaria flagelliformis* f. *chordaeformis* Kjellman]	+		+				b.-a.
Chordaria flagelliformis (O.F. Müller) C. Agardh	+	+	+	+			at.
Chordaria spp.	+					+	
Coilodesme californica (Ruprecht) Kjellman	+						p. st.-b.
Coilodesme cystoseirae (Ruprecht) Setchell et N.L. Gardner	+		+		+		p. wb.
Dictyosiphon chordaria Areschoug				+			b.-a.
Dictyosiphon foeniculaceus (Hudson) Greville	+			+	+		b.-a.
Eudesme virescens (Carmichael ex Berkeley) J. Agardh	+				+		?mz.
Leathesia marina (Lyngbye) Decaisne [=*Leathesia difformis* Areschoug]	+	+	+	+	+		mz.
Melanosiphon intestinalis (De A. Saunders) M.J. Wynne		+					ab., st.-b.
Punctaria chartacea Setchell et N.L. Gardner	+						p. wb.
Punctaria flaccida Nagai					+		as. lb.
Punctaria latifolia Greville					+		mz.
Punctaria occidentalis Setchell et N.L. Gardner	+						p. wb.
Punctaria plantaginea (Roth) Greville [=*Punctaria rubescens* (Lyngbye) J. Agardh]	+	+	+	+	+		?at.
Saundersella simplex (Saunders) Kylin			+	+			b.-a.
Sphaerotrichia divaricata (C. Agardh) Kylin [=*Sphaerotrichia japonica* Kylin]	+				+		at.

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
Streblonema fasciculatum Thuret					+		?at.
Familia Scytosiphonaceae							
Colpomenia sinuosa (Mertens ex Roth) Derbes et Solier			+		+		n.-tr.-b.
Petalonia fascia (O.F. Müller) Kuntze		+					mz.
Scytosiphon lomentaria (Lyngbye) Link, *nomen conservandum*	+	+	+	+	+		mz.
Ordo Fucales							
Familia Fucaceae							
Fucus evanescens C. Agardh	+	+	+	+			b.-a.
Silvetia babingtonii (Harvey) E.A. Serrão, T.O. Cho, S.M. Boo et Brawley [=*Pelvetia wrightii* Okamura]	+	+	+	+			as. lb.
Familia Sargassaceae							
Sargassum miyabei Yendo [=*Sargassum kjellmanianum* Yendo]	+	+	+	+	+		tr.-lb.
Sargassum pallidum (Turner) C. Agardh [as *Sargassum confusum* C. Agardh]					+		tr.-lb.
Sargassum thunbergii (Mertens ex Roth) Kuntze			+	+			tr.-lb.
Stephanocystis crassipes (Mertens ex Turner) Draisma, Ballesteros, F. Rousseau et T. Thibaut [=*Cystophyllum crassipes* (Mertens ex Turner) J. Agardh; *Cystoseira crassipes* (Mertens ex Turner) C. Agardh]	+		+		+		as. wb.
Stephanocystis geminata (C. Agardh) Draisma, Ballesteros, F. Rousseau et T. Thibaut [=*Cystoseira geminata* C. Agardh]					+		p. wb.
Stephanocystis hakodatensis (Yendo) Draisma, Ballesteros, F. Rousseau et T. Thibaut [=*Cystoseira hakodatensis* (Yendo) Fensholt]					+		tr.-lb.
Ordo Laminariales							
Familia Agaraceae							
Costaria costata (C. Agardh) De A. Saunders	+			+			p. wb.
Familia Alariaceae							
Alaria esculenta (Linnaeus) Greville [=*Alaria macroptera* (Ruprecht) Yendo]	+						b.-a.
Alaria marginata Postels et Ruprecht [=*Alaria taeniata* Kjellman]	+						p. wb.
Alaria ochotensis Yendo		+					as. wb.
Alaria praelonga Kjellman	+						p. wb.
Alaria spp.	+		+				
Familia Chordaceae							
Chorda asiatica Sasaki et Kawai [as *Chorda filum* (Linnaeus) Stackhouse]	+				+		as. wb.
Familia Laminariaceae							
Arthrothamnus bifidus (S.G. Gmelin) J. Agardh	+						p. wb.
Arthrothamnus kurilensis Ruprecht	+						?as. wb.
Laminaria digitata (Hudson) Lamouroux	+						st.-b.-a.
Saccharina gyrata (Kjellman) C.E. Lane, C. Mayes, Druehl et G.W. Saunders [=*Kjellmaniella gyrata* (Kjellman) Miyabe]	+		+				as. wb.
Saccharina japonica (Areschoug) C.E. Lane, C. Mayes, Druehl et G.W. Saunders [=*Laminaria japonica* Areschoug]	+			+			ab.
Saccharina spp.		+		+			
Familia Pseudochordaceae							
Pseudochorda nagaii (Tokida) Inagaki	+			+			as. lb.
Ordo Ralfsiales							
Familia Ralfsiaceae							
Analipus filiformis (Ruprecht) Papenfuss [=*Analipus fusiformis* Kjellman]	+						p. wb.

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
Analipus japonicus (Harvey) Wynne [=*Heterochordaria abietina* (Ruprecht ex Farlow) Setchell et N.L. Gardner]	+	+	+	+			p. wb.
Ralfsia fungiformis (Gunnerus) Setchell et Gardner	+			+			tr.-b.-a.
Ordo Sphacelariales							
Familia Sphacelariaceae							
Sphacelaria rigidula Kützing [=*Sphacelaria furcigera* Kützing]	+			+			?mz.
Regnum PLANTAE							
Phylum Rhodophyta							
Classis Bangiophyceae							
Ordo Bangiales							
Familia Bangiaceae							
Fuscifolium tasa (Yendo) S.C. Lindstrom [=*Porphyra tasa* (Yendo) Ueda]	+						p. wb.
Porphyra umbilicalis Kützing	+						mz.
Porphyra spp.	+		+	+			
Wildemania amplissima Foslie [=*Porphyra amplissima* (Kjellman) Setchell et Hus]	+						b.-a.
Wildemania variegata De Toni [=*Porphyra variegata* (Kjellman) Kjellman]	+						?tr.-b.
Classis Compsogonophyceae							
Ordo Erythropeltidales							
Familia Erythrotrichiaceae							
Erythrotrichia carnea (Dyllwin) C. Agardh				+			mz.
Erythrotrichia sp.				+			
Classis Florideophyceae							
Ordo Acrochaetiales							
Familia Acrochaetiaceae							
Acrochaetium kurilense (Nagai) Papenfuss	+						as. wb.
Acrochaetium moniliforme (Rosenvinge) Børgesen [=*Kylinia moniliformis* (Rosenvinge) Kyli]	+						?n.-tr.-b.
Acrochaetium reductum (Rosenvinge) Hamel	+						?n.-tr.-b.
Acrochaetium sp.	+						
Ordo Ahnfeltiales							
Familia Ahnfeltiaceae							
Ahnfeltia tobuchiensis (Kanno et Matsubara) Makienko [as *Ahnfeltia plicata* (Hudson) Fries]					+		as. lb.
Ordo Ceramiales							
Familia Ceramiaceae							
Antithamnion sp.	+						
Ceramium japonicum Okamura [as *Ceramium rubrum* C. Agardh]	+		+	+	+		as. st.-lb.
Ceramium kondoi Yendo	+		+				p. wb.
Familia Delesseriaceae							
Heteroglossum carnosum (Mikami) Perestenko [as *Okamurina pacifica* (Yamada) A.D. Zinova]	+						as. wb.
Tokidadendron bullatum (N.L. Gardner) M.J. Wynne	+						p. wb.
Familia Rhodomelaceae							
Chondria crassicaulis Harvey	+	+	+				tr.-lb.
Laurencia nipponica Yamada			+	+			?as. st.-lb.
Laurencia okamurae Yamada	+		+		+		tr.-st.
Laurencia spp.	+		+				
Neorhodomela aculeata (Perestenko) Masuda [as *Rhodomela larix* (Turner) C. Agardh; *Neorhodomela larix* (Turner) Masuda]	+	+	+	+			p. wb.
Neorhodomela munita (Perestenko) Masuda		+		+			as. lb.
Neorhodomela oregona (Doty) Masuda		+		+			p. wb.
Neosiphonia japonica (Harvey) M.-S. Kim et I.K. Lee	+						?at.

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
[=*Polysiphonia japonica* Harvey]							
Neosiphonia yendoi (Segi) M.S. Kim et I.K. Lee				+			as. lb.
Odonthalia annae Perestenko	+	+					as. wb.
Odonthalia corymbifera (S.G. Gmelin) Greville	+	+					?as. st.-b.
Odonthalia floccosa (Esper) Falkenberg [=*Odonthalia aleutica* (C. Agardh) J. Agardh]	+						p. wb.
Odonthalia kamtschatica (Ruprecht) J. Agardh	+						p. wb.
Odonthalia ochotensis (Ruprecht) J. Agardh		+					as. wb.
Polysiphonia morrowii Harvey				+			at.
Polysiphonia stricta (Dillwyn) Greville [=*Polysiphonia urceolata* (Lightfoot ex Dillwyn) Greville]	+						mz.
Pterosiphonia bipinnata (Postels et Ruprecht) Falkenberg		+					p. wb.
Rhodomela confervoides (Hudson) P.C. Silva [=*Rhodomela subfusca* (Woodward) C. Agardh]	+		+				b.-a.
Rhodomela sachalinensis Masuda				+			as. lb.
Familia Wrangeliaceae							
Neoptilota asplenioides (Esper) Kylin ex Scagel, Garbary, Golden et Hawkes [=*Ptilota asplenioides* (Esper) C. Agardh]	+	+	+				at.
Ptilota filicina J. Agardh	+		+	+			p. wb.
Ptilota spp.	+		+				
Ordo Corallinales							
Familia Corallinaceae							
Alatocladia modesta (Yendo) H.W. Johansen		+					as. lb.
Bossiella compressa N.G. Kloczcova [as *Amphiroa cretacea* (Postels et Ruprecht) Endlichter]	+	+		+			as. wb.
Corallina officinalis Linnaeus [=*Pachyarthron cretaceum* (Postels et Ruprecht) Manza; *Bossiella cretacea* (Postels et Ruprecht) H.W. Johansen]	+	+	+		+		mz.
Corallina pilulifera Postels et Ruprecht	+	+	+	+	+		n.-tr.-b.
Lithophyllum tumidulum Foslie		+		+			as. st.-lb.
Ordo Gigartinales							
Familia Dumontiaceae							
Constantinea rosa-marina (S.G. Gmelin) Postels et Ruprecht	+						p. wb.
Constantinea subulifera Setchell	+	+					p. wb.
Dilsea sp.	+						
Dumontia contorta (S.G. Gmelin) Ruprecht [=*Dumontia incrassata* (O.F. Müller) J.V. Lamouroux]	+						?b.-a.
Farlowia sp.	+						
Masudaphycus irregularis (Yamada) S.C. Lindstrom [=*Farlowia irregularis* Yamada]	+	+					as. st.-lb.
Neodilsea yendoana Tokida	+	+	+				as. wb.
Familia Endocladiaceae							
Gloiopeltis furcata (Postels et Ruprecht) J. Agardh	+	+		+	+		tr.-b.
Familia Gigartinaceae							
Chondrus armatus (Harvey) Okamura					+		?as. lb.
Chondrus pinnulatus (Harvey) Okamura	+	+	+	+	+		as. lb.
Chondrus yendoi Yamada et Mikami	+						as. lb.
Chondrus sp.	+						
Iridaea spp. [as *Iridaea subdichotomum*]	+		+				
Mazzaella japonica (Mikami) Hommersand [=*Rhodoglossum japonicum* Mikami]	+	+		+			as. lb.
Mazzaella parksii (Setchell et Gardner) Hughey, Silva et Hommersand [as *Iridaea cornucopiae* Postels et Ruprecht]	+	+	+				p. wb.
Mazzaella sp. [=*Iridophycus* sp.]	+						

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
Familia Kallymeniaceae							
Callophyllis rhynchocarpa Ruprecht			+				p. wb.
Callophyllis sp.					+		
Cirrulicarpus gmelinii (Grunow) Tokida et Masaki	+						p. wb.
Familia Phyllophoraceae							
Mastocarpus pacificus (Kjellman) Perestenko [=*Gigartina pacifica* Kjellman; *Gigartina ochotensis* (Ruprecht) Yendo]	+	+	+	+			p. wb.
Schizymenia dubyi (Chauvin ex Duby) J. Agardh [as *Schizymenia dubyi* var. *palmata* Yamada]	+						?n.-tr.-b.
Familia Tichocarpaceae							
Tichocarpus crinitus (S.G. Gmelin) Ruprecht	+	+	+	+			as. wb.
Ordo Gracilariales							
Familia Gracilariaceae							
Gracilaria vermiculophylla (Ohmi) Papenfuss [as *Gracilaria verrucosa* (Hudson) Papenfuss; *Gracilaria confervoides* (Linnaeus) Greville]	+		+		+		tr.-b.
Ordo Hapalidiales							
Familia Hapalidiaceae							
Clathromorphum sp.		+					
Lithothamnion spp.	+		+		+		
Melobesia spp.	+		+				
Ordo Hildenbrandiales							
Familia Hildenbrandiaceae							
Hildenbrandia rubra (Sommerfelt) Meneghini [as *Hildenbrandia prototypus* Nardo]	+						mz.
Hildenbrandia sp.	+						
Ordo Palmariales							
Familia Palmariaceae							
Devaleraea sp.		+					
Halosaccion glandiforme (S.G. Gmelin) Ruprecht	+		+				p. wb.
Halosaccion hydrophorum (Postels et Ruprecht) Kützing		+					p. wb.
Palmaria marginicrassa I.K. Lee		+					as. wb.
Palmaria stenogona Perestenko [as *Rhodymenia stenogona* Perestenko]	+		+	+			as. wb.
Ordo Rhodymeniales							
Familia Lomentariaceae							
Lomentaria hakodatensis Yendo		+		+			?n.-tr.-b.
Familia Rhodymeniaceae							
Sparlingia pertusa (Postels et Ruprecht) G.W. Saunders, I.M. Strachan et Kraft [=*Rhodymenia pertusa* (Postels et Ruprecht) J. Agardh]			+				b.-a.
Classis Stylonematophyceae							
Ordo Stylonematales							
Familia Stylonemataceae							
Stylonema alsidii (Zanardini) K.M. Drew [=*Goniotrichum elegans* (Chauvin) Zanardini]	+						n.-tr.-b.
Phylum Chlorophyta							
Classis Chlorophyceae							
Ordo Chlamydomonadales							
Familia Chlorochytriaceae							
Chlorochytrium sp.					+		
Classis Ulvophyceae							
Ordo Bryopsidales							
Familia Codiaceae							
Codium ritteri Setchell et N.L. Gardner [as *Codium dichotomum* S.F. Gray]	+						p. hb.
Codium yezoense (Tokida) K.L. Vinogradova	+		+				as. lb.

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
Ordo Cladophorales							
Familia Cladophoraceae							
Chaetomorpha aerea (Dyllwin) Kützing	+				+		n.-tr.-b.
Chaetomorpha cannabina (Areschoug) Kjellman	+		+		+		ab., st.-b.
Chaetomorpha ligustica (Kützing) Kützing		+					?mz.
Chaetomorpha linum (O.F. Müller) Kützing		+					n.-tr.-b.
Chaetomorpha melagonium (F. Weber et D. Mohr) Kützing	+	+					?mz.
Chaetomorpha moniligera Kjellman	+	+	+	+	+		as. lb.
Chaetomorpha spiralis Okamura [=*Chaetomorpha torta* (Farlow ex F.S. Collins) Yendo]	+				+		n.-tr.-st.
Chaetomorpha spp.	+	+	+	+	+		
Cladophora opaca Sakai		+		+			as. lb.
Cladophora speciosa Sakai		+					as. wb.
Cladophora stimpsonii Harvey	+	+					tr.-b.
Cladophora spp.	+		+		+		
Ordo Ulotrichales							
Familia Monostromataceae							
Monostroma grevillei (Thuret) Wittrock	+	+					?at.
Familia Ulotrichaceae							
Acrosiphonia duriuscula (Ruprecht) Yendo [=*Spongomorpha duriuscula* (Ruprecht) Collins; as *Acrosiphonia sonderi* (Kützing) Kornmann]	+		+				p. wb.
Pseudothrix groenlandica (J. Agardh) Hanic et S.C. Lindstrom		+					at.
Ulothrix flacca (Dillwyn) Thuret [=*Ulothrix pseudoflacca* Wille]		+					mz.
Urospora penicilliformis (Roth) Areschoug		+	+				?mz.
Ordo Ulvales							
Familia Kornmanniaceae							
Blidingia minima (Nägeli ex Kützing) Kylin [=*Enteromorpha minima* Nägeli ex Kützing]	+	+			+		mz.
Kornmannia leptoderma (Kjellman) Bliding [=*Monostroma zostericola* Tilden]	+						st.-b.-a.
Familia Ulvaceae							
Ulva clathrata (Roth) C. Agardh [=*Enteromorpha clathrata* (Roth) Greville]					+		mz.
Ulva compressa Linnaeus [=*Enteromorpha compressa* (Linnaeus) Nees]					+		mz.
Ulva intestinalis Linnaeus [=*Enteromorpha intestinalis* (Linnaeus) Nees]			+		+		mz.
Ulva lactuca Linnaeus [=*Ulva fenestrata* Postels et Ruprecht]	+	+	+	+	+		mz.
Ulva linza Linnaeus [=*Enteromorpha procera* K. Ahlner; *Enteromorpha linza* (Linnaeus) J. Agardh]		+	+		+		mz.
Ulva prolifera O.F. Müller [=*Enteromorpha prolifera* (O.F. Müller) J. Agardh]		+					mz.
Ulva spp. [=*Enteromorpha* sp.]			+		+		
Familia Ulvellaceae							
Ulvella lens P. Crouan et H. Crouan					+		mz.
Phylum Tracheophyta							
Classis Monocots							
Ordo Alismatales							
Familia Cymodaceaceae							
Phyllospadix iwatensis Makino [as *Phyllospadix scouleri* W.J. Hooker]	+	+	+	+			as. st.-lb.
Familia Zosteraceae							
Zostera japonica Ascherson et Graebner [as *Zostera nana*					+	+	tr.-b.

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
Roth]							
Zostera marina Linnaeus				+	+	+	ab., st.-b.
ANIMALS							
Regnum ANIMALIA							
Phylum Porifera							
Classis Calcarea							
Ordo Leucosolenida							
Familia Grantiidae							
Grantia sp.			+				
Familia Heteropiidae							
Sycettusa nemurensis (Hozawa, 1929) [=*Grantessa nemurensis* Hozawa, 1929]	+						as. wb.
Classis Demospongiae							
Ordo Halichondrida							
Familia Halichondriidae							
Halichondria panicea (Pallas, 1766)	+	+	+	+			st.-b.-a.
Halichondria sitiens (Schmidt, 1870)	+						b.-a.
Ordo Poecilosclerida							
Familia Esperiopsidae							
Amphilectus lobata (Bowerbank, 1866) [as *Mycale lobata* (Bowerbank, 1866)]	+						b.-a.
Familia Microcionidae							
Clathria pennata (Lambe, 1895) [=*Biemna pennata* Koltun, 1958]					+		ap.
Ophlitaspongia pennata (Lambe, 1894)[=*Tylodesma pennata* (Lambe, 1894)]			+				ap.
Familia Tedaniidae							
Tedania fragilis Lambe, 1894	+						p. wb.
Phylum Cnidaria							
Classis Hydrozoa							
Ordo Anthoathecata							
Familia Corynidae							
Coryne pusilla Gaertner, 1774	+						ab.
Coryne spp.	+	+					
Familia Eudendriidae							
Eudendrium vaginatum Allman, 1863 [=*Eudendrium annulatum* Norman, 1864]	+	+		+			ab.
Familia Tubulariidae							
Ectopleura larynx (Ellis et Solander, 1786) [=*Tubularia larynx* Ellis et Solander, 1786]	+	+					at.
Tubularia sp.	+						
Ordo Leptothecata							
Familia Campanulariidae							
Campanularia volubilis (Linnaeus, 1758)		+					st.-b.-a.
Obelia longissima (Pallas, 1766)		+					at.
Orthopyxis integra (McGillivray, 1842) [=*Campanularia integra* McGillivray, 1842]	+						b.-a.
Orthopyxis platycarpa Bale, 1914 [=*Campanularia platycarpa* (Bale, 1914)]	+		+				p. st.-b.
Familia Haleciidae							
Halecium lucium Antsulevich, 1980		+					as. lb.
Familia Plumulariidae							
Plumularia filicaulis Kirchenpauer, 1876		+					n.-tr.-lb.
Familia Sertulariidae							
Abietinaria filicula (Ellis et Solander, 1786)		+					ab.
Abietinaria inconstans (Clark, 1876) [=*Abietinaria costata* (Nutting, 1901)]	+						p. wb.
Abietinaria spiralis Naumov, 1960					+		as. lb.

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
Abietinaria thuiarioides (Clark, 1876)		+					b.-a.
Sertularella mutsuensis Stechow, 1931	+				+		as. wb.
Sertularella spinosa Kirchenpauer, 1884	+	+					as. wb.
Sertularia robusta (Clark, 1876)		+					ab.
Sertularia similis Clark, 1876		+					ab.
Classis Staurozoa							
Ordo Stauromedusae							
Familia Lucernariidae							
Haliclystus borealis Uchida, 1933	+		+				as. lb.
Classis Anthozoa							
Ordo Actiniaria							
Familia Actiniidae							
Aulactinia sp. [=*Bunodactis* sp.]	+						
Cnidopus japonicus (Verrill, 1871)	+	+	+	+			p. wb.
Oulactis orientalis (Averincev, 1967) [=*Anthopleura orientalis* Averincev, 1967; as *Anthopleura artemisia* (Pickering in Dana, 1846); *Anthopleura elegantissima* (Brandt, 1835); *Anthopleura xanthogrammica* (Brandt, 1835)]	+	+	+	+			as. wb.
Urticina kurila (Averincev, 1967) [=*Tealia coriacea kurila* Averincev, 1967]	+						as. lb.
Actiniidae gen. sp.				+			
Familia Condylanthidae							
Charisea saxicola Torrey, 1902	+	+		+			p. wb.
Familia Diadumenidae							
Diadumene lineata (Verrill, 1869) [=*Haliplanella luciae* (Verrill, 1898)]		+					p.-o.
Familia Metridiidae							
Metridium senile (Linnaeus, 1761)	+	+	+	+			p.-o.
Phylum Nemertea							
Classis Rhynchocoela							
Ordo Heteronemertea							
Familia Lineidae							
Lineus torquatus Coe, 1901	+						p. wb.
Ordo Tubulaniformes							
Familia Tubulanidae							
Tubulanus punctatus (Takakura, 1898)		+					as. st.-lb.
Phylum Annelida							
Classis Polychaeta							
Ordo Capitellida							
Familia Arenicolidae							
Abarenicola claparedi oceanica Healy et Wells, 1959 [as *Arenicola claparedi* Levinsen, 1884]	+				+		p. wb.
Abarenicola pacifica Healy et Wells, 1959					+	+	p. wb.
Branchiomaldane vincenti Langerhans, 1881	+						ab.
Familia Capitellidae							
Capitella capitata (Fabricius, 1780)	+	+	+	+	+		at.
Heteromastus filiformis (Claparède, 1864)	+						ab.
Heteromastus filiformis laminariae Zachs, 1923					+		as. lb.
Mediomastus californiensis Hartman, 1944	+		+		+		p. wb.
Familia Maldanidae							
Nicomache (*Nicomache*) *personata* Johnson, 1901	+				+		ab.
Maldanidae gen. sp.				+			
Ordo Cirratulida							
Familia Cirratulidae							
Cirratulus branchioculatus Chlebovitsch, 1959					+		as. lb.
Cirratulus cirratus (O.F. Müller, 1776)	+		+		+		p.-o.
Cirriformia tentaculata (Montagu, 1808) [=*Audouinia*	+						ab., st.-b.

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
tentaculata (Montagu, 1808)]							
Cirratulidae gen. sp.				+			
Ordo Echiurida							
Familia Echiuridae							
Echiurus echiurus echiurus (Pallas, 1766)					+		at.
Ordo Eunicida							
Familia Dorvilleidae							
Schistomeringos japonica (Annenkova, 1937) [=*Staurocephalus japonica* Annenkova, 1937; *Dorvillea japonica* (Annenkova, 1937)]					+		ap.
Familia Lumbrineridae							
Lumbrineris inflata Moore, 1911 [=*Lumbrinereis cervicalis* Treadwell, 1922]	+				+		p. wb.
Lumbrineris japonica (Marenzeller, 1879) [=*Lumbrineris latreilli japonica* Marenzeller, 1879]	+	+		+	+		ab., st.-b.
Familia Oenonidae							
Drilonereis filum (Claparède, 1868)	+						ab., st.-b.
Familia Onuphidae							
Nothria hyperborea (Hansen, 1878) [=*Onuphis conchylega* (Sars, 1835)]					+		b.-a.
Onuphis iridescens (Johnson, 1901)	+						at.
Ordo Flabelligerida							
Familia Flabelligeridae							
Pherusa plumosa (O.F. Müller, 1776) [=*Stylarioides plumosa* (O.F. Müller, 1776)]	+		+				st.-b.-a.
Ordo Opheliida							
Familia Opheliidae							
Armandia brevis (Moore, 1906)					+		p. wb.
Familia Scalibregmatidae							
Hyboscolex pacificus borealis Imajima et Hartman, 1964 [as *Oncoscolex pacificus* (Moore, 1909)]	+		+				ap.
Scalibregma sp.			+				
Ordo Orbiniida							
Familia Orbiniidae							
Naineris jacutica Annenkova, 1931 [=*Naineris laevigata* (Grube, 1855)]	+	+	+	+	+	+	as. lb.
Naineris quadricuspida (Fabricius, 1780)	+		+		+		b.-a.
Naineris sp.	+						
Orbiniella nuda Hobson, 1974		+					p. wb.
Protoariciella oligobranchia Hobson, 1976		+					ap.
Scoloplos armiger (O.F. Müller, 1776)	+				+		p.-o.
Ordo Phyllodocida							
Familia Glyceridae							
Glycera macrobranchia (Moore, 1911) [as *Glycera convoluta* Keferstein, 1862]	+				+		ap.
Familia Goniadidae							
Glycinde armigera Moore, 1911	+			+	+	+	ab.
Familia Nephtyidae							
Nephtys californiensis Hartman, 1938	+				+		ap.
Nephtys ciliata (O.F. Müller, 1776)	+						b.-a.
Nephtys longosetosa Örsted, 1842–1843	+				+		b.-a.
Familia Nereididae							
Alitta brandti Malmgren, 1865 [as *Nereis virens* M. Sars, 1835]			+			+	ab.
Hediste japonica (Izuka, 1908) [=*Neanthes japonica* (Izuka, 1908); *Nereis japonica* Izuka, 1908]	+				+	+	as. st.-lb.
Namanereis littoralis (Müller in Grube, 1871) [as *Lycastopsis augeneri* Okuda, 1937]	+				+		as. st.-lb.

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
Nereis pelagica Linnaeus, 1758	+	+			+	+	b.-a.
Nereis vexillosa Grube, 1851	+	+	+	+	+	+	p. wb.
Nereis zonata Malmgren, 1867	+	+	+	+			st.-b.-a.
Nereis zonata tigrina Zachs, 1933	+						as. wb.
Nereis spp.		+		+		+	
Platynereis bicanaliculata (Baird, 1863) [=*Platynereis agassizi* (Ehlers, 1868)]					+		ap.
Familia Phyllodocidae							
Eteone flava (Fabricius, 1780)	+		+				b.-a.
Eteone longa (Fabricius, 1780)	+	+	+		+		b.-a.
Eulalia viridis (Linnaeus, 1767)	+		+		+		ab., st.-b.
Eumida sanguinea (Örsted, 1843) [=*Eulalia sanguinea* (Örsted, 1843)]					+		ab., st.-b.
Nereiphylla hera Kato et Mawatari, 1999 [as *Phyllodoce castanea* (Marenzeller, 1879)]	+						as. lb.
Phyllodoce maculata (Linnaeus, 1767)	+		+		+		ab.
Familia Polynoidae							
Halosydna brevisetosa Kinberg, 1855 [as *Halosydna nebulosa* (Grube, 1866)]	+						ap.
Harmothoe imbricata (Linnaeus, 1767)	+	+	+	+	+		st.-b.-a.
Lepidonotus squamatus (Linnaeus, 1764)	+			+			ab.
Polynoidae gen. spp.		+		+			
Familia Syllidae							
Autolytus beringianus Annenkova, 1934	+						as. hb.
Autolytus caterinkae Uschakov, 1950	+						as. hb.
Exogone gemmifera Pagenstecher, 1862	+						st.-b.-a.
Proceraea prismatica (O.F. Müller, 1776) [=*Autolytus prismaticus* (O.F. Müller, 1776)]	+						b.-a.
Syllis armillaris (O.F. Müller, 1776) [=*Typosyllis armillaris* (O.F. Müller, 1776)]	+		+		+		p.-o.
Syllis cornuta Rathke, 1843 [=*Langerhansia cornuta* (Rathke, 1843)]			+				p.-o.
Syllis fasciata Malmgren, 1867 [=*Typosyllis fasciata* (Malmgren, 1867)]	+	+					b.-a.
Syllis hyalina Grube, 1863		+					ab., st.-lb.
Syllis oerstedi (Malmgren, 1867) [=*Typosyllis oerstedi* (Malmgren, 1867)]					+		b.-a.
Syllis variegata Grube, 1860 [=*Typosyllis variegata* (Grube, 1860)]	+		+		+		ab., st.-b.
Typosyllis adamanteus (Treadwell, 1914) [=*Typosyllis decorus* (Annenkova, 1934)]		+	+				as. st.-lb.
Typosyllis spp.	+	+	+	+			
Ordo Sabellida							
Familia Sabellidae							
Chone teres Bush, 1905	+	+		+			p. wb.
Chone spp.	+	+				+	
Eudistylia suavis (Grube, 1878) [=*Bispira polymorpha* Johnson, 1901]	+	+					ap.
Paradialychone cincta (Zachs, 1933) [=*Chone cincta* Zachs, 1933]	+						as. st.-lb.
Paradialychone ecaudata (Moore, 1923) [=*Chone ecaudata* (Moore, 1923)]		+					p. wb.
Potamilla neglecta (M. Sars, 1851)	+						at.
Pseudopotamilla myriops (Marenzeller, 1884) [=*Potamilla myriops* Marenzeller, 1884]	+	+					p. wb.
Pseudopotamilla occelata Moore, 1905		+					p. wb.
Sabellidae gen. sp.		+					
Familia Serpulidae							

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
Circeis spirillum (Linnaeus, 1758) [=*Spirorbis spirillum* (Linnaeus, 1758); *Dexiospira spirilla* (Linnaeus, 1758)]	+		+		+		b.-a.
Hydroides uncinata (Philippi, 1844)	+						tr.-b.
Laeospira granulata (Linnaeus, 1767)			+				b.-a.
Neodexiospira alveolata (Zachs, 1933) [=*Dexiospira alveolata* (Zachs, 1933)]	+		+		+		as. lb.
Paradexiospira vitrea (Fabricius, 1780)			+				b.-a.
Serpulidae gen. spp.	+	+	+	+	+		
Ordo Spionida							
Familia Spionidae							
Boccardia natrix Söderström, 1920	+		+				at.
Malacoceros (*Rhynchospio*) *arenincolus asiaticus* Chlebovitsch, 1959 [=*Rhynchospio arenincola* Hartman, 1936]	+	+	+				as. wb.
Microspio kussakini Chlebovitsch,1959			+				as. lb.
Scolelepis squamata (O.F. Müller, 1806) [=*Nerine cirratulus* (Delle Chiaje, 1831)]	+						ab., st.-lb.
Scolelepis spp. [=*Nerinides* sp.]	+	+					
Spio filicornis (O.F. Müller, 1776)	+	+					b.-a.
Spionidae gen. sp.		+					
Ordo Terebellida							
Familia Ampharetidae							
Schistocomus sovjeticus Annenkova, 1937	+						as. lb.
Familia Terebellidae							
Eupolymnia robusta (Annenkova, 1925) [as *Eupolymnia trigonostoma* (Schmarda, 1861); *Polymnia trigonostoma* (Schmarda, 1861)]	+				+		as. lb.
Neoleprea californica (Moore, 1904) [=*Terebella californica* (Moore, 1904)]	+						ap.
Pista elongata Moore, 1909	+				+		ap.
Phylum Sipuncula							
Classis Phascolosomatidea							
Ordo Phascolosomatiformes							
Familia Phascolosomatidae							
Phascolosoma (*Physcosoma*) *agassizii* Keferstein, 1866 [as *Phascolosoma japonicum* Grube, 1877]	+	+	+		+		tr.-b.
Phylum Arthropoda							
Classis Pycnogonida							
Ordo Pantopoda							
Familia Ammotheidae							
Achelia alaskensis (Cole,1904)	+						p. wb.
Achelia kurilensis Losina-Losinsky, 1961	+		+				as. wb.
Familia Nymphonidae							
Nymphon striatum Losina-Losinsky, 1929	+						as. lb.
Classis Maxillopoda							
Ordo Sessilia							
Familia Archaeobalanidae							
Semibalanus cariosus (Pallas, 1788) [=*Balanus cariosus* (Pallas, 1788)]	+	+	+		+		p. wb.
Familia Chthamalidae							
Chthamalus dalli Pilsbry, 1916	+	+	+	+	+		p. wb.
Classis Malacostraca							
Ordo Amphipoda							
Familia Ampithoidae							
Ampithoe kussakini Gurjanova, 1955	+	+	+	+			p. wb.
Ampithoe lacertosa Bate, 1858 [=*Ampithoe japonica* Stebbing, 1888]				+	+		p. wb.

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
Ampithoe tarasovi Bulycheva, 1952				+			as. lb.
Ampithoe volki Gurjanova, 1938				+			as. wb.
Ampithoe spp.		+		+	+	+	
Familia Anisogammaridae							
Anisogammarus pugettensis (Dana, 1853)	+		+		+		p. wb.
Carineogammarus makarovi (Bulycheva, 1952) [=*Anisogammarus makarovi* (Bulycheva, 1952)]	+		+		+		p. wb.
Eogammarus kygi (Derzhavin, 1923) [=*Anisogammarus kygi* (Derzhavin, 1923)]			+		+		as. wb.
Eogammarus possjeticus Tzvetkova, 1967 [=*Anisogammarus possjeticus* Tzvetkova, 1967]					+		as. lb.
Locustogammarus locustoides (Brandt, 1851) [=*Anisogammarus locustoides* (Brandt, 1851)]	+	+	+				p. wb.
Spasskogammarus spasskii (Bulycheva, 1952) [=*Anisogammarus spasskii* (Bulycheva, 1952)]	+	+	+	+			as. wb.
Familia Caprellidae							
Caprella bispinosa Mayer, 1890				+			as. st.-b.
Caprella cristibrachium Mayer, 1903	+	+	+	+			p. wb.
Caprella danilevskii Czerniavski, 1868	+		+				tr.-b.
Caprella irregularis Mayer, 1890				+			p. wb.
Caprella laeviuscula Mayer, 1903	+						p. wb.
Caprella mutica Schurin, 1935	+						as. lb.
Caprella spp.	+	+	+	+	+		
Familia Corophiidae							
Corophium crassicorne Bruzelius, 1859		+					ab.
Corophium steinegeri Gurjanova, 1951			+				as. wb.
Corophium spp.	+	+		+	+		
Familia Dexaminidae							
Atylus ekmani (Gurjanova, 1938)				+			as. wb.
Guernea (*Guernea*) *coalita* (Norman, 1868)					+		as. wb.
Familia Dogielinotidae							
Dogielinotus moskvitini (Derzhavin, 1930) [=*Allorchestes moskvitini* Derzhavin, 1930]	+		+		+	+	as. wb.
Familia Eusiridae							
Pontogeneia andrijaschevi Gurjanova, 1951					+		as. wb.
Pontogeneia intermedia Gurjanova, 1938		+					p. wb.
Pontogeneia kondakovi Gurjanova, 1951				+			as. wb.
Pontogeneia makarovi Gurjanova, 1951		+	+				as. wb.
Pontogeneia spp.		+		+	+		
Familia Hyalidae							
Allorchestes malleolus Stebbing, 1899	+	+		+	+	+	as. wb.
Apohyale bassargini (Derzhavin, 1937) [=*Hyale novaezealandiae* Bulycheva, 1957, non Thomson, 1879]	+	+		+			as. wb.
Parallorchestes ochotensis (Brandt, 1851)		+		+			p. wb.
Parallorchestes zibellina (Derzhavin, 1937) [=*Hyale zibellina* (Derzhavin, 1937)]	+		+				as. wb.
Familia Ischyroceridae							
Ischyrocerus anguipes Krøyer, 1838				+			b.-a.
Ischyrocerus cristatus Gurjanova, 1938		+		+			as. wb.

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
Ischyrocerus spp.		+		+			
Jassa marmorata Holmes, 1903		+					ab.
Familia Lysianassidae							
Anonyx sp.				+			
Lepidepecreum sp.						+	
Orchomene sp.				+			
Orchomenella spp.		+		+		+	
Lysianassidae gen. sp.					+		
Familia Melitidae							
Melita dentata (Krøyer, 1842)	+				+		b.-a.
Melita sp.					+		
Familia Photidae							
Pareurystheus sexdentatus (Stephensen, 1944) [=*Eurystheus sexdentata* Stephensen, 1944]					+		as. lb.
Protomedeia sp.					+		
Familia Pleustidae							
Pleusymtes japonica (Gurjanova, 1938)		+					as. lb.
Pleusymtes sp.				+			
Familia Stenothoidae							
Metopa sp.				+			
Stenothoidae gen. sp.					+		
Familia Talitridae							
Paciforchestia pyatakovi (Derzhavin, 1937) [=*Orchestia pyatakovi* Derzhavin, 1937]					+		as. lb.
Platorchestia crassicornis (Derzhavin, 1937) [=*Orchestia platensis* Bulycheva, 1957, non Krøyer, 1845; *Talorchestia crassicornis* Derzhavin, 1937]	+				+		as. lb.
Platorchestia pachypus (Derzhavin, 1937) [=*Talorchestia pachypus* Derzhavin, 1937]	+				+		as. st.-lb.
Platorchestia zachsi (Derzhavin, 1937) [=*Talorchestia zachsi* Derzhavin, 1937]	+		+		+		as. wb.
Traskorchestia ochotensis (Brandt, 1851) [=*Orchestia ochotensis* Brandt, 1851]	+				+		as. wb.
Trinorchestia trinitatis (Derzhavin, 1937) [=*Orchestoidea brito* Bulycheva, 1957, non Stebbing, 1891; *Orchestoidea trinitatis* Derzhavin, 1937]	+		+		+		ab.
Talitridae gen. sp.						+	
Ordo Cumacea							
Familia Diastylidae							
Diastylis lazarevi Lomakina, 1955	+						as. wb.
Ordo Decapoda							
Familia Cancridae							
Cancer gibbosulus (de Haan, 1835)	+						ap.
Familia Cheiragonidae							
Erimacrus isenbeckii (Brandt, 1848)		+					as. wb.
Telmessus cheiragonus (Tilesius, 1812)	+	+	+	+	+		p. wb.
Familia Crangonidae							
Crangon propinquus Stimpson, 1860 [=*Crangon septemspinosa* var. *propinqua* Stimpson, 1860]					+		as. wb.

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
Familia Epialtidae							
Pugettia quadridens (de Haan, 1839)	+		+	+			as. st.-lb.
Familia Hapalogastridae							
Dermaturus mandtii Brandt, 1850	+	+					p. wb.
Familia Hyppolytidae							
Eualus leptognathus (Stimpson, 1860) [=*Eualus japonica* (Yokoya, 1930)]					+		as. st.-lb.
Spirontocaris ochotensis mororani Rathbun, 1902					+		as. st.-lb.
Familia Lithodidae							
Paralithodes brevipes (A. Milne-Edwards et Lucas, 1841)	+	+					p. wb.
Familia Paguridae							
Pagurus brachiomastus (Thallwitz, 1891)	+	+	+	+	+		as. lb.
Pagurus hirsutiusculus (Dana, 1851)		+					p. wb.
Pagurus middendorffii Brandt, 1851	+	+	+	+	+		p. wb.
Familia Pandalidae							
Pandalus latirostris Rathbun, 1902	+		+		+		as. st.-b.
Pandalus prensor Stimpson, 1860 [=*Pandalus meridionalis* (Balss, 1914)]					+		as. st.-b.
Familia Pinnotheridae							
Pinnaxodes mutuensis Sakai, 1939 [as *Pinnaxodes major* Ortmann, 1894]	+						as. st.-lb.
Familia Porcellanidae							
Pachycheles stevensii Stimpson, 1858	+						as. st.-lb.
Familia Varunidae							
Eriocheir japonica (de Haan, 1835)	+		+		+		as. st.-lb.
Hemigrapsus penicillatus (de Haan, 1835) [=*Brachynotus penicillatus* (de Haan, 1835)]	+				+		as. st.-lb.
Hemigrapsus sanguineus (de Haan, 1835) [=*Brachynotus sanguineus* (de Haan, 1835)]	+				+		as. st.-lb.
Ordo Isopoda							
Familia Aegidae							
Rocinela maculata Schioedte et Meinert, 1879	+						as. lb.
Familia Cirolanidae							
Excirolana japonica (Thielmann, 1910)	+				+		as. st.-lb.
Familia Detonidae							
Detonella papillicornis (Richardson, 1904) [as *Detonella sackchalina* Verhoeff, 1942]	+		+		+		p. wb.
Familia Idoteidae							
Cleantiella isopus (Miers, 1881) [=*Cleantis isopus* Miers, 1881]	+			+			as. st.-lb.
Idotea gurjanovae Kussakin, 1974	+			+			as. wb.
Idotea ochotensis Brandt, 1851	+	+	+	+	+		as. wb.
Idotea orientalis Gurjanova, 1933	+						as. wb.
Synidotea lata Gurjanova, 1933 [as *Synidotea bicuspida* (Owen, 1839)]	+	+		+			as. wb.
Familia Janiridae							
Ianiropsis derjugini Gurjanova, 1933	+		+				p. wb.
Ianiropsis kincaidi Richardson, 1904	+		+				p. wb.
Ianiropsis setifera Gurjanova, 1950	+						as. wb.

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
Familia Ligiidae							
Ligia cinerascens Budde-Lund, 1885	+		+		+		as. st.-lb.
Familia Limnoriidae							
Limnoria lignorum (Rathke, 1799)	+		+				ab.
Familia Paranthuridae							
Paranthura japonica Richardson, 1909					+		as. st.-lb.
Familia Porcellionidae							
Porcellio scaber Latreille, 1804	+		+		+		p.-o.
Familia Sphaeromatidae							
Cliamenella fraudatrix (Kussakin, 1962) [=*Dynamenella glabra* non Richardson, 1899; *Dynamenella fraudatrix* Kussakin, 1962]	+	+	+	+	+		as. lb.
Cymodoce japonica Richardson, 1907 [as *Cymodoce acuta* Richardson, 1904]					+		tr.-lb.
Dynoides dentisinus Shen, 1929			+				as. st.-lb.
Gnorimosphaeroma noblei Menzies, 1954	+	+	+	+	+	+	p. wb.
Gnorimosphaeroma ovatum (Gurjanova, 1933) [as *Gnorimosphaeroma oregonense* (Dana, 1852)]	+		+		+		as. st.-lb.
Holotelson tuberculatus Richardson, 1909	+		+	+	+		as. st.-lb.
Familia Tecticipitidae							
Tecticeps glaber Gurjanova, 1933	+	+			+		as. lb.
Familia Tylidae							
Tylos granuliferus Budde-Lund, 1885 [=*Tylos granulatus* Miers, 1877]			+				as. st.-lb.
Ordo Leptostraca							
Familia Nebaliidae							
Nebalia bipes (Fabricius, 1780)					+		ab.
Nebalia japanensis (Claus, 1888)	+				+		as. lb.
Ordo Mysida							
Familia Mysidae							
Archaeomysis grebnitzkii Czerniavsky, 1882	+		+		+		p. wb.
Phylum Mollusca							
Classis Polyplacophora							
Ordo Chitonida							
Familia Acanthochitonidae							
Cryptochiton stelleri (Middendorff, 1847)	+						p. wb.
Familia Ischnochitonidae							
Ischnochiton hakodadensis Pilsbry, 1892	+			+			as. lb.
Familia Mopaliidae							
Mopalia schrencki Thiele, 1909	+			+			as. lb.
Mopalia seta Jakovleva, 1952	+	+		+			as. lb.
Familia Schizoplacidae							
Schizoplax brandtii (Middendorff, 1847)	+		+	+	+		p. wb.
Familia Tonicellidae							
Boreochiton granulatus (Jakovleva, 1952) [=*Tonicella granulata* Jakovleva, 1952]	+	+		+			as. wb.
Tonicella submarmorea (Middendorff, 1847)	+						p. wb.

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
Tonicella zotini Jakovleva, 1952	+						as. lb.
Classis Gastropoda							
Clade Patellogastropoda							
Familia Lottiidae							
Erginus (*Problacmaea*) *sybariticus* (Dall, 1871) [=*Problacmaea sybaritica* (Dall, 1871)]	+						p. wb.
Lottia ochracea (Dall, 1871) [=*Collisella patina* (Eschscholtz, 1833)]			+	+			p. wb.
Lottia pelta (Rathke, 1833) [=*Collisella cassis* (Eschscholtz, 1833)]	+	+	+	+			p. wb.
Lottia persona (Rathke, 1833) [=*Collisella radiata* (Eschscholtz, 1833)]	+	+	+	+			p. wb.
Nipponacmaea moskalevi Chernyshev et Chernova, 2002 [=*Acmaea grano-striata* (Schrenck, 1867)]					+		as. lb.
Niveotectura pallida (Gould, 1859) [=*Acmaea pallida* (Gould, 1859)]	+	+					as. st.-lb.
Notoacmea concinna (Lischke, 1870)					+		as. st.-lb.
Notoacmea schrenckii (Lischke, 1868)					+		as. st.-lb.
Lottiidae gen. spp.	+	+			+		
Clade Vetigastropoda							
Familia Trochidae							
Lirularia iridescens (Schrenck, 1863) [=*Minolia iridescens* (Schrenck, 1863); *Isanda iridescens* (Schrenck, 1863)]					+	+	as. lb.
Margarites helicinus (Phipps, 1774)	+		+				b.-a.
Margarites pilsbryi Kuroda et Habe, 1952	+		+				as. lb.
Familia Turbinidae							
Homalopoma sangarense (Schrenck, 1867) [=*Turbo sangarensis* Schrenck, 1867; *Leptothyra sangarensis* Pilsbry, 1888]			+	+	+		as. lb.
Clade Caenogastropoda							
Familia Barleeidae							
Ansola angustata (Pilsbry, 1901) [=*Barleeia angustata* (Pilsbry, 1901)]		+			+		as. st.-lb.
Familia Batillariidae							
Batillaria cumingii (Crosse, 1862) [=*Potamides aterrima* (Dunker, 1882)]					+	+	as. st.-lb.
Familia Buccinidae							
Buccinum baeri (Middendorff, 1848)	+						p. hb.
Buccinum middendorffi Verkrüzen, 1882		+		+	+		as. lb.
Buccinum mirandum mirandum E.A. Smith, 1875	+	+					as. wb.
Buccinum percrassum Dall, 1883	+						as. wb.
Buccinum sp. [as *Buccinum tricarinatum* Dall, 1877]					+		
Neptunea arthritica (Valenciennes, 1858)	+		+		+	+	as. lb.
Neptunea bulbacea (Valenciennes, 1858)	+						as. lb.
Volutharpa ampullacea (Middendorff, 1848)				+			p. wb.
Familia Caecidae							
Caecum derjugini Golikov et Kussakin in Golikov et Scarlato, 1967 [=*Brochina derjugini* Golikov, 1967]			+	+			as. lb.
Familia Calyptraeidae							

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
Crepidula derjugini Golikov et Kussakin, 1962		+					as. lb.
Crepidula grandis Middendorff, 1849	+		+				p. wb.
Crepidula spp.	+		+		+		
Familia Cerithiopsidae							
Cerithiopsis stejnegeri Dall, 1884	+					+	p. wb.
Familia Columbellidae							
Mitrella burchardi (Dunker, 1877) [=*Columbella dunkeri* sensu Kussakin, 1956, non Tryon, 1883; *Pyrene varians* (Sowerby I, 1832)]	+	+	+	+	+		as. lb.
Familia Falsicingulidae							
Falsicingula athera Bartsch in Golikov et Scarlato, 1967		+	+		+		as. lb.
Falsicingula kurilensis (Pilsbry, 1905) [=*Cingula kurilensis* Pilsbry, 1905]	+	+	+	+	+	+	as. wb.
Falsicingula mundana (Yokoyama, 1926) [=*Falsicingula elegans* Golikov et Kussakin in Golikov et Scarlato, 1967]			+				as. lb.
Familia Littorinidae							
Epheria decorata (A. Adams, 1861)			+				as. lb.
Epheria turrita (A. Adams, 1861)	+		+	+	+		as. lb.
Haloconcha minor Dall, 1919 [=*Lacuna minor* (Dall, 1919)]	+	+		+			p. wb.
Littorina brevicula (Philippi, 1844)					+		as. st.-lb.
Littorina mandshurica Schrenk, 1867	+		+				as. lb.
Littorina sitkana Philippi, 1846 [=*Littorina kurila* Middendorff, 1848]	+	+	+	+	+		p. wb.
Littorina squalida Broderip et Sowerby I, 1829	+	+	+	+	+		p. wb.
Stenotis uchidai Habe, 1953 [=*Lacuna uchidai* (Habe, 1953)]	+		+				as. lb.
Familia Muricidae							
Boreotrophon candelabrum (Reeve, 1848) [as *Trophon clathratus* (Linnaeus, 1767)]	+		+		+		as. lb.
Nucella elongata Golikov et Kussakin, 1974 [as *Thais lamellosa* (Gmelin, 1791)]	+		+		+		as. lb.
Nucella freycinetii (Deshayes, 1839) [=*Purpura freycinetii* Deshayes, 1839]	+	+	+		+		p. wb.
Nucella heyseana (Dunker, 1882)	+	+	+	+			as. lb.
Nucella lima (Gmelin, 1791) [=*Thais lima* (Gmelin, 1791)]	+		+		+		p. wb.
Ocenebra inornata (Rècluz, 1851) [=*Tritonalia japonica* (Dunker, 1860); *Ocenebra japonica* Pilsbry, 1895]	+				+		as. st.-lb.
Familia Nassariidae							
Nassarius fraterculus (Dunker, 1860) [=*Tritia fratercula* (Dunker, 1860)]	+	+	+	+	+	+	as. st.-lb.
Nassarius multigranosus (Dunker, 1847) [=*Tritia acutidentata* (E.A. Smith, 1879); *Alectrion festiva* (Powis, 1835)]	+				+	+	as. st.-lb.
Familia Naticidae							
Cryptonatica affinis (Gmelin, 1791) [=*Cryptonatica clausa* (Broderip et Sowerby I, 1829); *Natica clausa* Broderip et Sowerby I, 1829]	+		+		+		b.-a.
Cryptonatica hirasei (Pilsbry, 1905) [=*Boreonatica hirasei* (Pilsbry, 1905)]	+		+	+	+		as. lb.
Cryptonatica janthostoma (Deshayes, 1839)	+						as. wb.
Lunatia pila (Pilsbry, 1911) [=*Euspira pila* (Pilsbry,	+						as. lb.

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
1911)]							
Familia Pomatiopsidae							
Cecina manchurica A. Adams, 1861 [=*Truncatella tatarica* Schrenck, 1867]			+		+		as. wb.
Familia Ranellidae							
Fusitriton oregonensis (Redfield, 1846)	+						p. wb.
Familia Rissoidae							
Alvania sp.	+						
Pusilina plicosa (Smith, 1875) [=*Thapsiella plicosa* (Smith, 1875)]				+	+	+	as. lb.
Familia Velutinidae							
Velutina coriacea Pallas, 1788 [=*Velutina litoralis* Golikov et Kussakin, 1967]	+						as. wb.
Velutina tarasovi Derjugin, 1950 [=*Velutina fraudatrix* Golikov et Kussakin, 1962]	+						as. wb.
Velutina spp.	+	+					
Clade Heterobranchia							
Familia Cylichnidae							
Decorifer matusimanus (Nomura, 1939) [=*Acteocina insignis* (Pilsbry, 1904)]			+				as. st.-lb.
Familia Flabellinidae							
Coryphella athadona Bergh, 1875		+					p. wb.
Familia Pyramidellidae							
Iolaea dubia Golikov et Kussakin, 1967			+		+		as. lb.
Pyrgolampros rufofasciata (E.A. Smith, 1875)			+				as. lb.
Familia Rissoellidae							
Jeffreysina violacea Golikov et Kussakin, 1971	+						as. lb.
Familia Siphonariidae							
Siphonacmea oblongata (Yokoyama, 1926)					+		as. lb.
Classis Bivalvia							
Ordo Arcida							
Familia Glycymerididae							
Glycymeris yessoensis (Sowerby III, 1889) [as *Glycymeris albolineata* (Lischke, 1872)]	+		+		+		as. lb.
Ordo Myida							
Familia Myidae							
Mya arenaria Linnaeus, 1758			+		+		b.-a.
Mya japonica Jay, 1857					+		p. wb.
Familia Pholadidae							
Penitella penita (Conrad, 1837)	+						p. wb.
Familia Teredinidae							
Teredo navalis Linnaeus, 1758			+				ab., st.-lb.
Ordo Mytilida							
Familia Mytilidae							
Adula schmidtii (Schrenck, 1867)		+					as. lb.
Modiolus kurilensis Bernard, 1983 [=*Modiolus modiolus* (Linnaeus, 1758)]	+	+			+		as. st.-b.
Musculista senhousia (Benson in Cantor, 1842) [=*Brachidontes senhousia* (Benson in Cantor, 1842)]		+			+		?as. st.-lb.

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
Musculus laevigatus (Gray, 1824)		+			+		b.-a.
Mytilus trossulus kussakini Scarlato et Starobogatov, 1979 [as *Mytilus edulis* Linnaeus, 1758]		+			+		as. wb.
Vilasina pillula Bartsch in Scarlato, 1960		+			+		as. lb.
Ordo Ostreida							
Familia Ostreidae							
Crassostrea gigas (Thunberg, 1793)	+						as. st.-lb.
Ordo Pectinida							
Familia Pectinidae							
Mizuhopecten yessoensis (Jay, 1856)	+		+		+		as. lb.
Ordo Pholadomyida							
Familia Lyonsiidae							
Entodesma navicula (A. Adams et Reeve, 1850) [=*Entodesma naviculoides* Yokoyama, 1922]	+						as. lb.
Entodesma sp.	+						
Lyonsia sp.		+					
Ordo Venerida							
Familia Cardiidae							
Clinocardium californiense (Deshayes, 1839) [=*Keenocardium californiense* (Deshayes, 1839)]	+						p. wb.
Familia Lasaeidae							
Mysella kurilensis litoralis Scarlato et Ivanova, 1974		+		+			as. wb.
Familia Mactridae							
Spisula sachalinensis (Schrenck, 1861) [=*Mactra sachalinensis* Schrenck, 1861]	+						as. lb.
Familia Psammobiidae							
Nuttallia ezonis Kuroda et Habe in Habe, 1955					+		as. lb.
Nuttallia obscurata (Deshayes in Reeve, 1857) [=*Nuttallia olivacea* (Jay, 1857)]					+		as. st.-lb.
Familia Tellinidae							
Cadella lubrica (Gould, 1861) [=*Moerella salmonea* Carpenter, 1864]	+						as. st.-lb.
Macoma incongrua (Martens, 1865)					+	+	as. st.-lb.
Megangulus luteus (Wood, 1828) [=*Peronidia lutea* (Gray, 1828)]	+				+		p. wb.
Megangulus venulosus (Schrenck, 1861) [=*Tellina venulosa* Schrenck, 1861; *Peronidia venulosa* (Schrenck, 1861)]	+				+		as. lb.
Familia Veneridae							
Protothaca euglypta (Sowerby III, 1914) [as *Protothaca staminea* (Conrad, 1837)]	+	+		+	+		as. st.-lb.
Ruditapes philippinarum (A. Adams et Reeve, 1850) [=*Venerupis philippinarum* (A. Adams et Reeve, 1850); *Venerupis japonica* (Deshayes, 1853)]	+				+	+	as. st.-lb.
Turtonia minuta (Fabricius, 1780)	+	+	+	+	+	+	ab.
Incerti ordinis							
Familia Hiatellidae							
Hiatella arctica (Linnaeus, 1767) [=*Saxicava arctica* (Linnaeus, 1767)]	+	+	+		+		b.-a.
Panomya sp.		+					

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
Panopea japonica A. Adams, 1850			+				as. lb.
Familia Pharidae							
Siliqua alta (Broderip et Sowerby I, 1829) [as *Siliqua pulchella* (Dunker, 1852)]	+				+		p. wb.
Phylum Bryozoa							
Classis Gymnolaemata							
Ordo Cheilostomata							
Familia Bugulidae							
Bugula pacifica Robertson, 1905		+					p. wb.
Dendrobeania flustroides (Levinsen, 1887)		+					b.-a.
Familia Calloporidae							
Cauloramphus echinus (Hincks, 1882)	+						p. wb.
Cauloramphus spiniferum (Johnston, 1832)	+				+		ab.
Familia Candidae							
Tricellaria ternata (Ellis et Solander, 1786)	+						b.-a.
Familia Celleporidae							
Celleporina nordenskjoldi (Kluge, 1929) [=*Cellepora nordenskjoldi* Kluge, 1929]	+	+			+		b.-a.
Familia Cryptosulidae							
Cryptosula zavjalovensis Kubanin, 1976 [=*Lepralia pallasiana* (Moll, 1803)]	+	+					p. wb.
Familia Hippothoidae							
Celleporella hyalina (Linnaeus, 1767) [=*Hippothoa hyalina* (Linnaeus, 1767)]	+	+	+		+		b.-a.
Familia Microporellidae							
Fenestrulina malusii (Audouin, 1826) [=*Microporella malusii* (Audouin, 1826)]					+		p.-o.
Familia Smittinidae							
Smittina minuscula (Smitt, 1868)	+						b.-a.
Ordo Ctenostomata							
Familia Alcyonidiidae							
Alcyonidium mamillatum Alder, 1857					+		b.-a.
Alcyonidium mytili Dalyell, 1847	+						b.-a.
Familia Flustrellidridae							
Flustrellidra cervicornis (Robertson, 1900)	+						p. hb.
Flustrellidra corniculata (Smitt, 1872) [=*Flustrella corniculata* (Smitt, 1872)]	+	+					b.-a.
Familia Vesiculariidae							
Bowerbankia composita Kluge, 1955		+					b.-a.
Bowerbankia sp.					+		
Classis Stenolaemata							
Ordo Cyclostomata							
Familia Lichenoporidae							
Lichenopora sp.		+					
Familia Tubuliporidae							
Tubulipora sp.					+		
Phylum Echinodermata							
Classis Asteroidea							

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
Ordo Forcipulatida							
Familia Asteriidae							
Aphelasterias japonica (Bell, 1881)			+				as. lb.
Asterias amurensis Lütken, 1871	+		+		+		?at.
Distolasterias elegans Djakonov, 1931			+		+		as. lb.
Evasterias retifera Djakonov, 1938			+		+		p. wb.
Leptasterias (*Eoleptasterias*) *kussakini* Baranova, 1962			+				?as. lb.
Leptasterias (*Eoleptasterias*) *similispinis* (H.L. Clark, 1908)	+						as. lb.
Lethasterias fusca Djakonov, 1931			+		+		as. lb.
Lethasterias nanimensis chelifera (Verrill, 1914)			+				p. wb.
Asteriidae gen. sp.		+					
Familia Pycnopodiidae							
Lysastrosoma anthosticta Fischer, 1922			+				as. lb.
Ordo Spinulosida							
Familia Echinasteridae							
Henricia tumida Verrill, 1914			+				p. wb.
Henricia sp.					+		
Ordo Valvatida							
Familia Asterinidae							
Asterina pectinifera (Müller et Troschel, 1842) [=*Patiria pectinifera* (Müller et Troschel, 1842)]					+		as. st.-lb.
Classis Ophiuroidea							
Ordo Ophiurida							
Familia Ophiactidae							
Ophiopholis aculeata (Linnaeus, 1767)	+		+				ab.
Classis Echinoidea							
Ordo Camarodonta							
Familia Strongylocentrotidae							
Strongylocentrotus intermedius (A. Agassiz, 1863)	+	+	+	+			as. wb.
Classis Holothuroidea							
Ordo Aspidochirotida							
Familia Stichopodidae							
Apostichopus japonicus (Selenka, 1867)				+			as. st.-lb.
Ordo Dendrochirotida							
Familia Sclerodactylidae							
Eupentacta fraudatrix (Djakonov et Baranova in Djakonov et al., 1958) [=*Cucumaria fraudatrix* Djakonov et Baranova in Djakonov et al., 1958]	+		+				as. wb.
Eupentacta sp. [as *Cucumaria chronhjelmi* Théel, 1886]	+						
Ordo Synaptida							
Familia Synaptidae							
Synaptidae gen. sp.					+		
Phylum Chordata							
Classis Ascidiacea							
Ordo Aplousobranchia							

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
Familia Holozoidae							
Distaplia spp.	+		+		+		
Ordo Stolidobranchia							
Familia Styelidae							
Botryllus schlosseri (Pallas, 1766)			+				p.-o.
Classis Actinopterygii							
Ordo Perciformes							
Familia Gobiidae							
Gobiidae gen. sp.					+		
Familia Pholididae							
Pholis nebulosus (Temminck et Schlegel, 1845)	+						as. lb.
Pholis pictus (Kner, 1868)	+						as. wb.
Rhodymenichthys dolichogaster (Pallas, 1814) [=*Pholis dolichogaster dolichogaster* (Pallas, 1814)]	+						p. wb.
Familia Stichaeidae							
Alectrias alectrolophus (Pallas, 1814)	+	+		+			p. wb.
Opisthocentrus ocellatus (Tilesius, 1811)						+	as. wb.
Pholidapus dybowskii (Steindachner, 1880) [=*Opisthocentrus dybowskii* (Steindachner, 1880)]	+						as. wb.
Stichaeopsis nana Kner et Steindachner, 1870	+						as. lb.
Stichaeidae gen. sp.					+		
Familia Zoarcidae							
Zoarces elongatus Kner, 1868 [=*Zoarces viviparus elongatus* Schmidt, 1950]	+						as. wb.
Ordo Pleuronectiformes							
Familia Pleuronectidae							
Pleuronectidae gen. spp.			+		+		
Ordo Scorpaeniformes							
Familia Cottidae							
Myoxocephalus stelleri Tilesius, 1811	+		+		+		as. wb.
Porocottus allisi (Jordan et Starks, 1904)			+				as. lb.
Cottidae gen. spp.	+		+		+		
Familia Hemitripteridae							
Blepsias cirrhosus (Pallas, 1814)	+						p. wb.
Familia Hexagrammidae							
Hexagrammos octogrammus (Pallas, 1810)	+						p. wb.
Familia Scorpaenidae							
Sebastes schlegeli Hilgendorf, 1880	+						as. lb.